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R. G. KOOPMANS

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PROEFSCHRIFT TER VERKRIJGING VAN DEN GRAAD VAN DOCTOR IN DE WIS- EN NATUURKUNDE AAN DE RIJKSUNIVERSITEIT TE UTRECHT, OP GEZAG VAN DEN RECTOR-MAGNIFICUS DR. B. J. H. OVINK, HOOGLEERAAR IN DE FACULTEIT DER LETTEREN EN WIJSBEGEERTE, VOLGENS BESLUIT VAN DEN SENAAT DER UNIVERSITEIT TEGEN DE BEDENKINGEN VAN DE FACULTEIT DER WIS- EN NATUURKUNDE TE VERDEDIGEN, OP DINSDAG 3 JULI 1928, DES NAMIDDAGS TE 4 UUR

DOOR

REITZE GERBEN KOOPMANS

GEBOREN TE AMSTERDAM

N. V. BOEK- EN HANDELSDRUKKERIJ V/H JOS. PENNERS, HEERLEN
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Geologisch Bureau voor het Nederlandsche Mijngebied

Flora en Fauna van het Nederlandsche Karboon

Uitgegeven door

W. J. JONGMANS

I

AAN MIJN OUDERS

WOORD VOORAF

Het is mij een aangename plicht, mijn dank te betuigen aan allen, die, hetzij voor, hetzij gedurende mijn studie medegewerkt hebben aan mijn wetenschappelijke ontwikkeling en die bij daardoor in staat gesteld hebben dit onderwerp te bewerken.

Hooggeleerde JORDAN en WENT, U dank ik voor Uw lessen over Physiologie.

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Hooggeleerde PULLE, hooggeachte promotor: als liefhebber-florist kwam ik aan als student, als wetenschappelijk florist, zij het dan ook „fossiel", verlaat ik de Universiteit. Uw hulp en leiding hebben mij steeds in het goede spoor gehouden.

INTRODUCTION

It was not before the beginning of the year 1926, that coal-balls were found in the Dutch coal-district, and I accepted gladly the offer of DR. W. J. JONGMANS to do the preliminary research-work on this beautiful and abundant material. Up to the present time only a brief note on the Dutch coal-balls has been published (KOOPMANS 1927), containing a short enumeration of the species found at the date of publication.

LOCALITY. — The Dutch coal-balls are found in the Finefrau-Nebenbank seam of the Domaniale Mijn at Kerkrade, Dutch Limburg. Usually they are somewhat round in shape, their diameter varying from 1 to 25 cm. At one place, the whole seam appears to be petrified, a bed of dolomite being found instead of a seam of coal containing concretions.

	THE NETHERLANDS	GERMANY	BELGIUM	FRANCE	GREAT BRITAIN
PERMIAN				Autun (Silicified plants)	
STEPHANIAN					
WESTFALIAN	**C** Aegir Horizon	Aegir Horizon	*Petit Buisson*	Petit Buisson (Pas de Calais: Rimbert)	Mansfield Horizon = Twist Coal
	B Katharina Horizon	*Katharina Horizon*	Poisson-nière	Poissonnière	
	A *Finefrau Horizon*	*Finefrau Horizon*	*Désirée = Bouxharmont*	Passée de Laure	*Lower Mountain Seam = Upper Foot Seam = Halifax Hard Bed*
NAMURIAN					
DINANTIAN				Esnost (Silicified plants)	Northumber-land = Pettycur = Dalmeny, etc. (Calcified and Silicified plants)

Table A.: Stratigraphical distribution of true coal-balls. The horizons, in which they have been found, in italics.

STRATIGRAPHY. — Table A shows the horizon in which our coal-balls are found. As DR. W. J. JONGMANS has authorized me to announce an article by him on the stratigraphy of this horizon, which will appear in the "Jaarverslag 1927" (Annual report) of the „Geologisch Bureau voor het Nederlandsche Mijngebied", it is unnecessary to go into details of this subject.

FORMATION OF COAL-BALLS. — Coal-balls are calcareous concretions, which are only found in those seams which have a marine roof, indicative of slow submergence by the sea. They consist of a mass of plant remains, which has been completely penetrated by inorganic matter, much in the same way as plants prepared for microtome-cutting are impregnated by paraffine, the salts having been derived from the sea, which deposited the roof. A few roof-nodules have been found also, which, however, unfortunately do not enclose any plant-remains, containing only *Goniatite* shells. As to further particulars regarding the origin and the structure of coal-balls, I refer to the comprehensive article by STOPES AND WATSON (1909).

PRESERVATION. — It is very curious that the organic tissues in the Dutch coal-balls and in those from the colliery Rheinpreussen, both of which belong to the Finefrau-Nebenbank seam, are pitch-black, while those from the English material and from the German Katharina seam are of various shades of brown, the carbonization of the Dutch and German Finefrau-Nebenbank material having gone further than in the other nodules. In many cases the plant-remains are preserved with great beauty, although I must own, that the details as seen in English slides are often not present in the Dutch balls, e.g. pits on the walls and sculpturing of spores. This may be due, however, to the fact of the English slides having been cut from chosen material.

	DOMANIALE MIJN	RHEINPREUSSEN	BOUXHARMONT	JUPILLE	BACUP	BURNLEY	DEIGHTON	DULESGATE	HALIFAX	HUDDERSFIELD	OLDHAM	SHORE	STALYBRIDGE	STRINESDALE	FINEFRAU-NEBENBANK	VOLLMOND	MARIA	KATHARINA
Amyelon radicans	■	■	■					■	■		■	■		■	■	■	■	■
Anachoropteris Williamsoni	■	■			■						■	■			■	■	■	■
Ankyropteris corrugata		■	■				■	■		■					■			
Ankyropteris Grayi									■		■	■						
Ankyropteris westfaliensis	■	■	■				■		■	■	■	■	■		■			
Ankyropteris Williamsoni												■						
Bothrodendron mundum			■	■	■		■	■	■	■		■	■	■	■		■	■
Botryopteris cylindrica			■	■			■		■	■					■			
Botryopteris Fraiponti			■												■			
Botryopteris tridentata	■	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■
Calamites communis	■	■	■	■		■	■	■	■	■	■	■	■	■	■	■	■	■
Calamostachys Binneyana	■	■	■					■	■	■	■	■	■	■	■	■		■
Calamostachys Casheana			■						■					■	■			
Calamostachys oldhamia	■										■				■			
Conostoma anglo-germanicum		■						■				■			■	■		■
Conostoma oblongum							■	■	■		■	■						
Cordaites Felicis	■	■	■					■	■			■			■	■	■	■
Etapteris Bertrandi											■	■						
Etapteris Scotti	■	■	■				■	■	■		■	■	■		■	■	■	■
Heterangium sp.							■	■	■	■		■				■	■	■
Lagenostoma Lomaxi							■	■			■	■						

	DOMANIALE MIJN	RHEINPREUSSEN	BOUXHARMONT	JUPILLE	BACUP	BURNLEY	DEIGHTON	DULESGATE	HALIFAX	HUDDERSFIELD	OLDHAM	SHORE	STALYBRIDGE	STRINESDALE	FINEFRAU-NEBENBANK	VOLLMOND	MARIA	KATHARINA
Lagenostoma ovoides	✓	✓			✓		✓	✓	✓	✓	✓	✓	✓		✓		✓	✓
Lepidocarpon Lomaxi	✓	✓	✓	✓				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Lepidodendron aculeatum	✓											✓			✓			
Lepidodendron Hickii	✓	✓						✓							✓			
Lepidodendron macrophyllum								✓			✓							
Lepidodendron obovatum	✓	✓										✓			✓			
Lepidodendron vasculare		✓	✓			✓		✓	✓	✓	✓	✓	✓		✓	✓		✓
Lepidophloios laricinus	✓	✓						✓	✓			✓	✓		✓			
Lepidophloios macrolepidotus	✓											✓			✓	✓		
Lepidostrobus Binneyanus	✓														✓			✓
Lepidostrobus foliaceus	✓								✓						✓			
Lepidostrobus gracilis		✓											✓		✓			
Lepidostrobus oldhamius	✓	✓	✓			✓	✓	✓	✓	✓	✓	✓	✓		✓	✓		
Lyginopteris oldhamia	✓	✓	✓	✓	✓		✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Mazocarpon shorense	✓	✓			✓		✓	✓	✓			✓	✓		✓		✓	✓
Medullosa anglica	✓	✓									✓	✓	✓		✓	✓	✓	✓
Medullosa centrofilis												✓						
Mesostrobus Scottii								✓										
Mesoxylon multirame	✓											✓			✓			
Mesoxylon poroxyloides												✓						
Miadesmia membranacea								✓					✓					
Mitrospermum compressum								✓			✓	✓	✓					
Myeloxylon	✓	✓						✓			✓	✓	✓	✓	✓	✓		
Palaeostachya vera	✓										✓			✓	✓			
Physostoma elegans	✓	✓			✓			✓	✓		✓	✓			✓			
Psaronius Renaultii											✓	✓						
Pteridotheca Williamsoni		✓									✓	✓						
Sigillaria sp.	✓	✓	✓		✓			✓	✓	✓	✓	✓	✓		✓			
Sigillariopsis laevis	✓											✓			✓			
Sigillariopsis sulcata								✓				✓						
Spencerites insignis			✓				✓	✓	✓	✓			✓		✓			
Spencerites majusculus									✓		✓	✓						
Sphenophyllostachys Dawsoni	✓	✓	✓		✓				✓		✓	✓	✓		✓			
Sphenophyllostachys fertilis												✓						
Sphenophyllum minus	✓	✓										✓			✓			
Sphenophyllum perforatum	✓														✓			
Sphenophyllum plurifoliatum	✓	✓	✓				✓	✓	✓	✓	✓	✓	✓		✓	✓	✓	
Stauropteris oldhamia	✓	✓		✓				✓	✓		✓	✓	✓	✓	✓	✓	✓	✓
Stigmaria arachnoidea	✓														✓			✓
Stigmaria bacupensis			✓		✓		✓			✓		✓			✓			

	DOMANIALE MIJN	RHEINPREUSSEN	BOUXHARMONT	JUPILLE	BACUP	BURNLEY	DEIGHTON	DULESGATE	HALIFAX	HUDDERSFIELD	OLDHAM	SHORE	STALYBRIDGE	STRINESDALE	FINEFRAU-NEBENBANK	VOLLMOND	MARIA	KATHARINA
Stigmaria ficoides (axis)	■	■	■	■		■	■	■			■	■			■	■		■
Stigmaria Lohesti			■												■			
Stigmaria Weissiana			■												■			
Telangium Scotti	■										■	■			■			
Trigonocarpus Parkinsoni		■									■	■			■			
Trigonocarpus shorensis												■						
Xenophyton radiculosum									■									

Table B.: Geographical distribution of coall-ball plants. The first group of columns contains continental localities from the Finefrau-Nebenbank Seam, the second the English ones. The Finefrau-Nebenbank column is a compilation of the species found till now on the continent. The last group contains the localities from the German Katharina Seam.

GEOGRAPHICAL DISTRIBUTION. — In table B I have collected all data regarding the distribution of coal-ball plants I have been able to gather from the literature and from the catalogues of the Utrecht, Amsterdam, Groningen, Heerlen, Liège, and Manchester collections of slides. It is very unfortunate that these data are not always reliable. Several times I have met with slides from the same block, which, according to the label and the catalogue, were found in different localities! The only data which can be relied upon are those from the Dutch, German, and Belgian material. Nevertheless it is possible to state that the flora of all localities is very much the same. Thanks to the kindness of DR. SUSANNE LECLERCQ and PROF. FRAIPONT, who allowed me to examine the Belgian collection of slides from Bouxharmont, I am able to compare more carefully the flora of this locality with the Dutch one, both of which are from the same stratigraphical horizon, but about 25 Km apart (Table C).

	HOLLAND	BELGIUM
Botryopteris cylindrica	—	+
Stauropteris oldhamia	+	—
Lyginopteris oldhamia	+	—
Lagenostoma ovoides	+	—
Medullosa anglica-Myeloxylon	×	—
Mesoxylon multirame	×	—
Lepidodendron vasculare	—	+
Lepidodendron Hickii	+	—
Lepidophloios laricinus	×	—
Lepidophloios macrolepidotus	×	—
Lepidostrobus oldhamius	+	—
Sigillarian leaf-bases	+	—

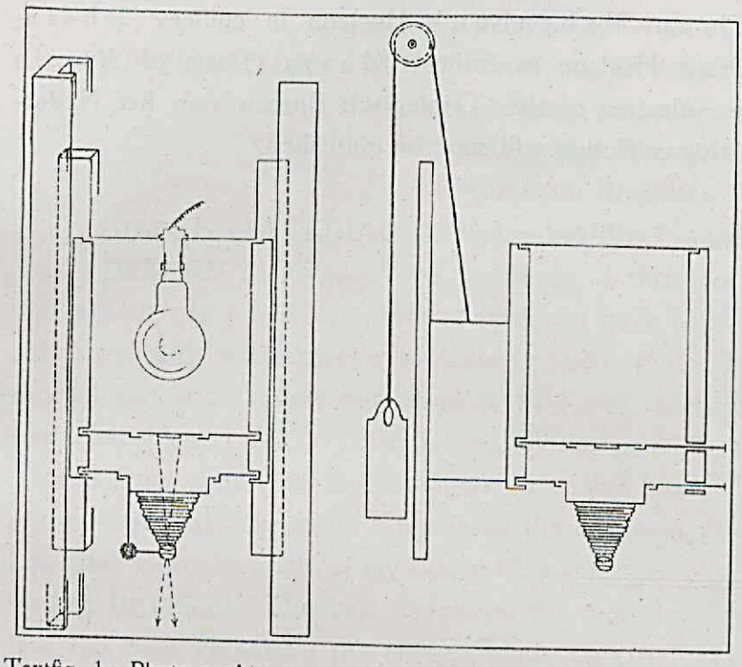
+ : *very common.*
× : *common.*
— : *absent or very rare.*

Table C.: Comparison of the Dutch and Belgian Finefrau-Nebenbank flora.

In this table I have mentioned only those species, which are common in one of them, and absent or very rare in the other. Of the Belgian balls about 1000 have been cut; of the Dutch material about 200 have been examined, thirty of which were investigated only superficially. There is no doubt that in composition these floras differ slightly, but this difference is comparable with that existing in many cases between two parts of the same moor in modern times. As yet it is impossible to state definitely the origin of this difference, but it is due in all probability to some oecological reason.

TECHNICAL REMARKS. — All slides have been cut and ground by the author. Although this has taken a considerable amount of time, he thinks it advisable that every student of this subject should take the trouble to do so. Only by observing every stage in the preparation of each slide, is it possible to gain a satisfactory insight into the way in which these fossil plants are built up. The method of grinding slides is very easily learned, and the time spent in grinding is regained while examining the sections.

The photographs have been taken by the author. The best results he has got with orthochromatic ultra-rapid press plates „Argus" (H & D 700), made by the N. V. Photax of Soest, Holland. The lens used in nearly all cases is the lens of his photographic camera — a Doppelanastigmat Unofocal, 1 : 6,8, f = 10,5 cm, Steinheil, Muenchen. No intricate camera was used — a simple magnifying apparatus constructed by himself for negatives complied with all requirements! Text-figure 1 shows its construction. Inside a light-tight box the slide is illuminated by an opal-glass electric bulb of 200 candle-power. The slide is put on a drawer with an opening in the centre. The camera is attached to a second drawer by means of a plate-holder, the bottom of which has been cut out. The whole box can be moved up and down by means of a pulley and a counterpoise in order to secure different magnifications. The image is focussed on a piece of paper, lying on the table, which after focussing is replaced by the plate.



Textfig. 1 : Photographic apparatus, used in taking the photos with which this article is illustrated.

ACKNOWLEDGEMENTS. — First of all I wish to express my thanks to Professor Dr. A. PULLE of the Utrecht Botanical Museum, whose lectures on Systematical Botany have kindled in me the desire to do some research on the origin of the present-day land-flora, who has allowed me to choose this Palaeobotanical subject for my Botanical thesis, and who has shown great interest in the results of my work. For his ever-ready assistance and advice, I am greatly indebted to him. To Dr. W. J. JONGMANS I am deeply grateful for the kindness with which he has placed this splendid material at my disposal, the help he has given me by his advice in many doubtful cases, the liberality with which he has permitted me to use his collection of books and reprints on this subject, many of which I could not have procured in any other way, and the permission to illustrate this article as fully as the rich harvest of species deserves. My thanks are due to the directors of the Domaniale Mijn, Mr. W. HUSMAN and Ir. J. H. W. SCHAEFER, for facilities in collecting material and for permission to publish the results of my research. I am very much indebted to Professor Dr. L. RUTTEN of Utrecht for permission to use the cutting and grinding apparatus of the Mineralogical and Geological Museum, which has enabled me to make as many slides as I deemed necessary. For hospitality at several laboratories and permission to examine collections of slides I have to thank Professor GEORGE HICKLING and Dr. D. A. ALLAN of Newcastle and Dr. R. G. ABSALOM, now of Liverpool, Dr. G. H. CARPENTER and Mr. J. W. JACKSON of the Manchester Museum, Professor F. E. WEISS and Mr. JOHN WALTON of the Manchester Botanical Department,

Professor C. FRAIPONT and Dr. SUSANNE LECLERCQ of Liége, Professor Dr. TH. STOMPS of Amsterdam, Professor Dr. J. C. SCHOUTE and Professor Dr. J. H. BONNEMA of Groningen. In addition I have to thank Professor PAUL BERTRAND of Lille and Professor A. RENIER of Bruxelles for their kindness in examining several of my slides. In conclusion I am much obliged to Drs. J. S. H. BOERSMA of Amsterdam and to Dr. DOUGLAS A. ALLAN of Newcastle for their helpful criticism of the English of my memoir.

The data regarding the species from the Finefrau-Nebenbank Horizon in colliery Rheinpreussen (near Duisburg) and the Katharina Horizon in colliery Maria (Basin of Aix la Chapelle) are based on slides and specimens in the collection of the "Geologisch Bureau voor het Nederlandsche Mijngebied" at Heerlen. The catalogue of this collection will soon be published.

DESCRIPTION OF SPECIES

LEPIDOPHLOIOS LARICINUS Sternberg.

Lepidophloios spec.

1893. Williamson, On the organization etc., XIX, p. 20, figs 30-39.
1908. Bower, Landflora, p. 304, fig. 52.
1909. Lotsy, Bot. Stammesgesch., II, fig. 303-3.
1910. Seward, Fossil Plants, II, figs 146 F, 147.
1920. Scott, Studies, 3d Ed., I, p. 139, figs 65-66.

Lepidophloios fuliginosus Koopmans (non Williamson)

1926. Koopmans, Jaarverslag 1926, p. 50.

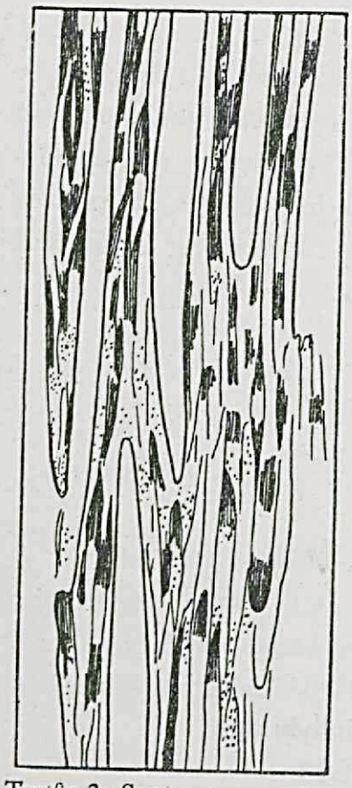
DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale Mijn.
Germany: Rheinpreussen.
England: Bradshaw, Dulesgate, Halifax, Shore, Stalybridge.

DUTCH MATERIAL. — Slides 144/0/1-3, 144/8/1-10, 144/9/1-10, 144/13/1-13.

DESCRIPTION. — Two specimens of this species have been found in the Dutch material, both in coal-ball 144. In other balls isolated pieces of bark with adherent leaf-bases have been met with. At first I did not know with what species to identify these stems, but in looking through the Manchester collection of slides I met with a slide numbered R 1015 and labelled: „*Lepidophloios laricinus*. Identified D. M. S. WATSON. See block. WILD collection of Blocks", which whithout any doubt is identical with my specimens. I learned from a note in the catalogue, that this block (No. 1578) showed the surface-markings of *Lepidophloios laricinus* Sternberg. Thanks to the Museum Authorities, who kindly allowed me to borrow this block, I am able to give a photo in my figure 12. I am indebted to DR. JONGMANS for confirmation of the identification by DR. WATSON. The ball had been cut into three pieces previously. The section in the Manchester collection has been cut along the oblique plane (see fig. 12). It shows the beautifully preserved xylem in transverse section. The structure of the leaf-bases is only moderately clear and the middle and inner cortex are not preserved. My description of this species is based on the Dutch material and on several slides from the Manchester and Heerlen collections, the numbers of which are appended.

MEDULLA. — The pith (fig. 5, 6) is composed of an irregular mass of parenchyma. Many cells, not only towards the edge of the pith but also in the centre, are divided by one or more walls. In longitudinal section the medulla is seen to consist of elongated parenchymatous cells arranged in vertical rows. These cells are separated by horizontal walls, but secondary oblique and even vertical walls also occur.

XYLEM. — The wood consists of a continuous ring of scalariform tracheides. The main body is about 4-6 tracheides broad, but on the outer side these large ones give place to a narrow belt of much smaller tracheides. This belt is usually one, sometimes two, tracheides broad. The protoxylem-points form a beautifully developed corona (fig. 5, 6). They consist of triangular groups of 20-30 tiny tracheides. At the base, i.e. at the surface of the metaxylem, the triangles approach one another. I have ground very carefully some slides tangentially up to the xylem (fig. 11) in order to decide, in what way the protoxylem-ridges are distributed on the surface of the metaxylem. C. E. BERTRAND, in his excellent monograph on *Lepidodendron Harcourtii* (1891), states that the ridges split open while giving off a leaf-trace, and that the halves fuse with those to the left and to the right, forming a prominent network. This opinion is based on the study of transverse sections only. SEWARD (1910, p. 163), however, figures a small piece of a tangential section of *Lepidodendron fuliginosum* and states that the protoxylem-ridges run in vertical lines and do not form a



Textfig. 2 : Section tangential to the xylem of Lepidophloios laricinus, showing the network of protoxylem-ridges on the surface of the xylem.

network. SCOTT (1920) mentions both opinions but does not definitely support either. Of course BERTRAND'S statement refers to *Lepidodendron Harcourtii,* but I am not convinced that he has used the true *Lepidodendron Harcourtii.* In Manchester I have seen slides cut from Halifax Hard Bed material and identical with those figured by BERTRAND, who does not, however, state the origin of his slides. SEWARD'S statement refers to *Lepidodendron fuliginosum,* but as in transverse sections it is impossible to distinguish the xylem of my species from that of the *L. Harcourtii* figured by BERTRAND and of *L. fuliginosum,* I thought it worth while to investigate my material most minutely. A careful study of my slides has convinced me that BERTRAND was right: the ridges form a network with very long and narrow meshes. I have not seen the slide from which SEWARD has formed his opinion, but I think it highly probable that the piece of stem cut tangentially was either too short or was not cut exactly in the right plane. Figure 11 and textfig. 2 show part of the section in which the fusion of the ridges is shown most clearly.

LEAF-TRACE. — The mesarch leaf-traces are formed inside the protoxylemridges (fig. 6). When these have split open as described above, at first the traces remain parallel to the xylem, and then pass very gradually outwards, assuming an almost horizontal course about halfway to the leaf-bases.

CORTEX. — In the Dutch specimens the cortex is not preserved. In the Manchester Museum collection is a slide, numbered R 284, and labelled „Halonial or Lepidendroid stem from Sholver near Oldham", and in the collection of DR. JONGMANS there are two independent slides, numbered 221 and 222, and labelled „*Lepidodendron fuliginosum* from Shore", all three of which apparently belong to *Lepidophloios laricinus,* as shown by the structure of the xylem and the leaf-bases, in which the cortical tissues are beautifully preserved. They quite agree with the well-known cortex of *Lepidodendron fuliginosum.* It is therefore highly probable, that *Lepidodendron fuliginosum sensu stricto,* as for instance described by F. E. WEISS (1903) and by SEWARD (1910, p. 141-152, figs 162-171), is identical with *Lepidophloios laricinus,* as I have not been able to detect any differences between the structure of these stems without leaf-bases and those of *Lepidophloios laricinus.* Of course I do not refer to the *Lepidodendron* figured as *L. fuliginosum* by WILLIAMSON (XI, fig. 9) and copied by SEWARD (1910, fig. 172) and SCOTT (1920, fig. 72) as this is a stem of *Lepidodendron Hickii* cut somewhat obliquely. (Compare fig. 29).

LEAF-BASE. — As to the form and structure of the leaf-bases I refer to my figures 1-4, 7-10, which also clearly show the ligula, the ligular pit, the vascular bundle, and the parichnos. The base of the ligula is provided with abundant transfusion tissue. The vascular bundle and the parichnos pass horizontally through the outer cortex and bend downwards parallel to the under surface of the leaf-base. Just under the base of the ligula the parichnos divides into two. I have not been able to trace a surface extension of the parichnos as an aerenchyma as in *Lepidodendron Hickii, L. obovatum,* and *L. aculeatum.*

TYPE SLIDES. — I regard the following slides as belonging to this species:

a: the slides of the Dutch material mentioned above.

b: Slides in the Manchester collection: R 223, 224, 285-289, 292, 307, 308, 311, 993 1015, 1093, 1149/3, 1150/1-3, 1268, 1273-1276, 1285, Q 435.

c: Slides in the Heerlen collection: 218-220, 221/1-6, 222, 223/1-5.

d: Slides in the Groningen collection: G 74-79.

LEPIDOPHLOIOS MACROLEPIDOTUS Goldenberg.

Lepidophloios macrolepidotus Goldenberg.

1893-1. Potonié, Zeitschr. Deutsch. Geol. Ges., XLV, p. 330.

1893-2. Potonié, Ber. Deutsch. Bot. Ges., XI, p. 319-326, Taf. XIV.

1899. Potonié, Pflanzenpalaeont., p. 235, figs 223-224.

Lomatophloios macrolepidotus (Goldenberg) Corda.

1881. Weiss, Zeitschr. Deutsch. Geol. Ges., XXXIII, p. 354.

1890. Seward, Proc. Cambr. Phil. Soc., VII, (1890) 1892, p. 43, Pl. III.

1908. Bower, Landflora, p. 305.

Lepidophloios laricinus Lomax (non Sternberg).

1927. Koopmans, Jaarverslag 1926, p. 51.

Lepidophloios sp.

1910. Seward, Fossil Plants, II, fig. 146D.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.

Loc. – Limburg: Domaniale Mijn.
England: Shore.

Hor. – Katharina.

Loc. – Germany: Vollmond.

DUTCH MATERIAL. — 8/1/1-5, 8/2/1-10, 8/3/1-4, 162/0/1-2, and several slabs from coal-ball 162.

DESCRIPTION. — Figure 91 shows the surface of a beautiful specimen of *Lepidophloios macrolepidotus*, contained in a coal-ball from the English Coal-measures. This block is in the collection of the Geologisch Bureau voor het Nederlandsche Mijngebied at Heerlen. As shown by sections in several directions this stem is in all respects identical with two stems from the Dutch material. All the other photographs have been taken from the Dutch stems with reflected light from the etched surface of polished slabs. It is very curious that this stem, which is fairly abundant both in the English and the Dutch coal-balls, occurs very rarely as an impression. Till now it has not been found as such in Dutch Limburg!

XYLEM. — The only slide I have seen in which the protoxylem is preserved is one cut from the block of figure 91, which can also be found in the Heerlen collection. (Fig. 91 bis) The protoxylem is of the type of that of *Lepidophloios laricinus*, a well-developed corona being present.

In none of the Dutch specimens, in which the xylem is shown, the protoxylem has been preserved. The metaxylem of one of the Dutch specimens (fig. 90) consists of a collapsed ring of tracheides, about 7 elements broad, which now has a length of about 5 cm, so that the diameter of the ring must have been about 3 cm.

LEAF-BASE. — As to the form and structure of the leaf-bases, I refer to my figures 13-22, which show the leaf-base cut in three directions and in several planes. Photographs 23-26 have been taken from another specimen, in which the lower half of the leaf-cushion has developed a knob, which in tangential section is shown as a separate structure. The leaf-trace and the parichnos pass horizontally through the outer cortex, but in the leaf-base they bend downwards parallel to its under surface. No aerenchymatic surface extension of the parichnos can be traced. POTONIÉ (1893-2) is of the opinion that aerenchyma is present, but his assumption is based on a block from which no sections have been cut, and his figure gives the impression that, in breaking off the top of a leaf-base, the parichnos-tissue has adhered to the underlying cushion.

AFFINITIES. — By several authorities on impressions the possibility is mentioned that *Lepidophloios macrolepidotus* is only an adult form of *Lepidophloios laricinus*. As I have been able to compare carefully the structure of both stems, I have tried to form an independent opinion. The vertical development of the leaf-base and especially the downward extension of the lower half in *Lepidophloios macrolepidotus*, as shown in radial and tangential sections (see figs 15, 20-23) are features, which are quite different from those of *Lepido-*

phloios laricinus, and which can only be reconciled by supposing considerable growth in length of the leaf-bases. As till now no facts have been discovered supporting this supposition, I cannot accept the theory that *Lepidophloios laricinus* and *Lepidophloios macrolepidotus* represent one form, and I therefore regard them as two quite independent species.

LEPIDODENDRON HICKII Watson.

Lepidodendron Hickii Watson.

1907. Watson, Mem. Proc. Lit. Phil. Soc. Manch., LI, 3, p. 1, Pl. I-III.
1908. Scott, Studies, 2d Ed., I, p. 135.
1910. Seward, Fossil Plants, II, p. 156.
1911. Zalessky, Etudes paléobot.,I, p. 1, figs 14-15.
1920. Scott, Studies, 3d Ed., I, p. 120.
1927. Koopmans, Jaarverslag 1926, p. 50.

Lepidodendron Harcourtii Williamson (non Witham).

1881. Williamson, On the organization etc., XI, p. 288, fig. 9.
1889. Williamson, On the organization etc., XVI, p. 196, figs 1-6.
1893. Williamson, On the organization etc., XIX, p. 1, figs 1-2B, 4, 6, 8-14, 16-21, 26-29*.
1893. Williamson, Index, II, p. 19. (pro parte).
1894. Williamson, Proc. Roy. Soc. London, LV, p. 422.

Lepidodendron fuliginosum Williamson.

1887. Williamson, Proc. Roy. Soc. London, XLII, p. 6.
1893. Williamson, Index, II, p. 13. (pro parte).
1910. Seward, Fossil Plants, II, p. 153, fig. 172.

Lepidodendron obovatum Zalessky (non Sternberg).

1911. Zalessky, Etudes paléobot., I, p. 10.
1927. Hirmer, Handbuch, I, p. 219.

Lepidophloios fuliginosus (Williamson) Scott.

1908. Scott, Studies, 2d Ed., I, p. 172, fig. 69.
1920. Scott, Studies, 3d Ed., I, p. 153, fig. 72.

Halonia regularis Binney.

1872. Binney, Observations, III, p. 89, Pl. XVI, figs 1-5, Pl. XVII, figs 1-6.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale Mijn.
Germany: Rheinpreussen.
England: Dulesgate, Stalybridge.

DUTCH MATERIAL. — Slides 13/1/1-2, 13/2/1-3, 13/3/1-7, 67/0/1-2, 78/0/1, 148/0/1, 148/2/1. 160/10/1-9.

EXTENSIVE DESCRIPTION. — See above: WATSON 1907.

DESCRIPTION. — The Dutch specimens are all about twice as big as the English type-specimens in the Manchester Museum collection. The diameter averages 3 cm against ± 1,5 cm for the English specimens.

MEDULLA. — The pith is composed of an irregular mass of parenchyma (fig. 28). Nearly every cell towards the edge of the pith is divided by one or more walls. In longitudinal section the pith is seen to consist of elongated parenchymatous cells, arranged in vertical rows. These cells are separated by horizontal walls, but secondary oblique walls also occur.

XYLEM. — The wood (fig. 28) consists of a continuous ring of scalariform tracheides of fairly

uniform size, 4-6 elements broad. On the outside these large tracheides give place to a narrow belt of much smaller tracheides, which is only 1 or 2 tracheides wide. The protoxylem points consist of small groups of tracheides, which seldom project more than two tracheides and do not form a corona.

PHLOEM and INNER CORTEX. — These have not been preserved.

MIDDLE CORTEX. — Where preserved it is composed of parenchymatous cells, which form a spongy mass.

OUTER CORTEX. — This consists of smaller and thicker-walled cells.

PERIDERM. — One, perhaps several layers of phellogen are present, but as the preservation is bad, nothing can be recognized with certainty.

LEAF-TRACE. — The leaf-trace immediately after leaving the wood of the axis (fig. 28) is a small mesarch bundle of about 10 or 12 tracheides. Their further course could not be followed.

LEAF-BASE. — The cushion has the form of a truncated rhombic pyramid, measuring about 6 mm horizontally, 5 mm vertically, and projecting about 4 mm from the surface of the stem. (figs 27, 29-32) The vascular bundle enters the leaf-base almost horizontally at about $^1/_3$ of its height, and passes straight on to the leaf-scar. The ligular pit begins at about the centre of the leaf-base and runs upwards in an oblique direction at an angle of 45°. The structure of the ligula is not preserved. The base of the ligula received an abundant supply of transfusion tracheides. The parichnos is first seen as a single strand of parenchyma immediately below the vascular bundle. Soon this strand divides into two, which gradually diverge towards the outside, till they communicate with two depressions on the lower surface of the cushion, which are filled with a typical aerenchymatous tissue (figs 27, 30).

BRANCHING OF STELE. — This has been observed in blocks 148 and 168. It seems to be of the usual Halonial type, a small portion of the xylem separating off and passing out.

LEAF. — No leaves have been found in organic connection or associated with the stem.

LEPIDODENDRON OBOVATUM Sternberg.

Under this name two specimina have been described:

a: specimen of SCOTT.

1906. Scott, Ann. of Bot., XX, p. 317.

1910. Seward, Fossil Plants, II, p. 154, fig. 173.

1927. Hirmer, Handbuch, I, p. 222. [*Lepidodendron fuliginosum* Hirmer (non Williamson)].

b: specimen of ZALESSKY.

1911. Zalessky, Etudes paléobotaniques, I, p. 1, figs 1-13, 16-24.

1912. Zalessky, Ibid. suppl., p. 17, figs 1, 5-9.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.

Loc. – Limburg: Domaniale Mijn.

Germany: Rheinpreussen.

England: Shore.

DUTCH MATERIAL. — Polished slabs from coal-ball 167.

EXTENSIVE DESCRIPTION. — See above: ZALESSKY 1911. The specimen of SCOTT has not yet been described extensively.

DESCRIPTION. — In coal-ball 167 is contained a *Lepidodendron*, the leaf-bases of which are also shown on the outer surface of the block (fig. 48). Although the external tissues are missing, their form is typical enough to warrant identification with *Lepidodendron obovatum* Sternberg. This identification is confirmed by the study of sections of not-exposed leaf-bases. Of the xylem many remains are present, which, however, are isolated owing to the crushing and do not form a continuous ring.

XYLEM. — The xylem (fig. 89) is of the type of *Lepidodendron Hickii*: a metaxylem of rather

large tracheides, on the outer surface of which a number of narrow elements represent the protoxylem. This is not developed as a corona, being only slightly crenulated. The total measurements before crushing cannot be ascertained.

CORTEX. — The soft tissues between the xylem and the outer cortex have all disappeared.

LEAF-BASES. — The leaf-bases are about 13 mm broad, 22 mm high, and 7 mm thick. The vascular bundle, the parichnos, and the ligular pit are directed obliquely upwards. The parichnos communicates with two well-developed masses of aerenchyma. The keel of the leaf-bases is furrowed by several horizontal grooves, which, however, are less in number and further apart than in *Lepidodendron aculeatum*. Figs 34-50 give an idea of the different forms the leaf-bases may assume in different planes of section.

LEPIDODENDRON ACULEATUM Sternberg.

Under this name three specimina have been described:

a: Specimen of SEWARD.

1906. Seward, Ann. of Bot., XX, p. 371, textfigs 1-3, Pl. XXVI.
1908. Scott, Studies, 2d Ed., I, p. 155.
1909. Zalessky, Mem. Imp. Russ. Mineral. Soc., XLVI, p. 302.
1910. Seward, Fossil Plants, II, p. 156, figs 174-176.
1920. Scott, Studies, 3d Ed., I, p. 137.
1927. Hirmer, Handbuch, I, p. 222. [*Lepidodendron fuliginosum* Hirmer (non Williamson)].

b: Specimina I and II of ZALESSKY.

1909. Zalessky, Mem. Imp. Russ. Mineral. Soc., XLVI, p. 283, Pl. IV-VII, 3 textfigs.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale Mijn.
England: Shore.

DUTCH MATERIAL. — Coal-ball 166.

EXTENSIVE DESCRIPTION. — See above: ZALESSKY 1909.

DESCRIPTION. — In coal-ball 166 is present the flattened stem of a *Lepidodendron*. The periderm and the leaf-bases are well preserved, but of the xylem only small fragments can be traced. No transparant slides of this stem have been ground, as the structure can be observed very well on the etched surface of polished slabs. The photographs also have been taken with reflected light.

XYLEM. — With regard to the structure of the xylem, nothing can be learned from the literature. SEWARD (1906) has described a specimen, in which the woody cylinder shows the characteristics of *Lepidodendron „fuliginosum"*, i. e. a well-developed corona. Unfortunately in his specimen nearly all the tissue of the leaf-bases has been lost, as shown in the photo of a transverse section. In my opinion his specimen may belong as well to *Lepidophloios macrolepidotus* as to *Lepidodendron aculeatum*. (Compare figs 23 and 53, both of which have been cut in the plane by which SEWARD'S specimen is limited.)

ZALESSKY (1909) has described two specimens, in the first of which the wood is preserved, but the second consists only of the periderm and the leaf-bases. I am not convinced, however, that these two specimens belong to the same species. Specimen II is in all respects identical with my specimen. The form of the leaf-bases of specimen I in transverse section is very curious, being bladder-like and swollen; in radial section their upper part hangs over somewhat, resembling an underdeveloped *Lepidophloios* (ZALESSKY, 1909, Pl. IV, figs 5 and 9.). The ligular pit, the leaf-trace, and the parichnos of specimen I are curved, ending in a downward direction, while in specimen II and in my specimen they are straight, having a course directed steeply upwards. According to ZALESSKY the surface of the block showed the leaf-bases of *Lepidodendron aculeatum*. The figure, which ought to prove this, is unfortunately not very distinct (ZALESSKY, 1909, text-

fig. 1). At present I cannot regard ZALESSKY'S specimen I as identical with *Lepidodendron aculeatum* Sternberg and even I should not wonder, if additional material should prove its identity with *Lepidodendron Jaraczewskii* Zeiller. Therefore his description of the xylem cannot be used in describing the structure of *Lepidodendron aculeatum*, and so it is impossible as yet to postulate with certainty the presence of a corona or the development of the protoxylem as in *Lepidodendron Hickii*.

LEAF-BASE. — The leaf-bases are about 30 mm high, 10 mm broad, and 5 mm thick. The leaf-cicatrice is placed at about a third of the distance from the top. The vascular bundle, the parichnos, and the ligular pit are directed obliquely upwards. The parichnos communicates with two well-developed masses of aerenchyma. The keel of the leaf-base is furrowed by several horizontal grooves, simulating in tangential and radial sections a number of thorn-like projections. Figs 51-60 give an idea of the different forms the leaf-base may assume in different planes of section.

LEPIDOSTROBUS OLDHAMIUS Williamson.

Lepidostrobus oldhamius Williamson.

1893. Williamson, On the organization etc., XIX, p. 27, figs 58-62.
1899. Maslen, Trans. Linn. Soc. London, (2), Bot., V, p. 361. figs 1-20 (forma α), p. 366, figs 23-35 (forma β), p. 371, fig. 21 (forma γ).
1908. Scott, Studies, 2d. Ed., I, p. 176.
1908. Zalessky, Mém. Com. Géol., Nouv. Sér., 46, p. 20, Pl. V, fig. 2, Pl. VII, fig. 1.
1910. Seward, Fossil Plants, II, p. 188, figs 191A-D.
1914. A. Arber, Trans. Linn. Soc. London, (2), Bot., VIII, p. 208, textfig. 1 (forma β), p. 220, figs 13-14, 43-49 (forma minor), p. 223, figs 50-54, textfigs 2-4 (forma pilosus).
1920. Scott, Studies, 3d Ed., I, p. 158.
1921. Potonié-Gothan, Palaeobot., p. 206.
1927. Koopmans, Jaarverslag 1926, p. 50.
1927. Hirmer, Handbuch, I, p. 230.

Lepidostrobus fuliginosus Leclercq.

1925. Leclercq, Mém. in 4° de la Soc. Géol. de Belg., VI, p. 40, Pl. XXI-XXIV, figs 11-16.

Lepidostrobus sp.

1886. Felix, Abh. Geol. Spezialk. Preussen, VII, 3, p. 35, Taf. IV, figs 1-3.

Lepidocarpon sp.

1909. Lotsy, Bot. Stammesgesch., II, p. 472, figs 317 : 1-5.

Lepidodendron Harcourtii Binney (non Witham).

1871. Binney, Observations, II, p. 46, Pl. VII, figs 1-5, 7-10.

Lepidodendron vasculare Binney.

1871. Binney, Observations, II, p. 49, Pl. VIII, figs 1-9.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale Mijn.
Germany: Rheinpreussen.
Belgium: Bouxharmont.
England: Burnley, Deighton, Dulesgate, Halifax, Huddersfield, Oldham, Shore, Stalybridge.
Hor. – Katharina.
Loc. – Germany: Vollmond.

DUTCH MATERIAL. — Slides 28/1/1-5, 28/2/1-4, 28/3/1-2, 28/6/1, 28/13/1-2, 102/2/1-3, 131/0/1-7, 144/11/1-2, 145/2/1-4.

EXTENSIVE DESCRIPTION. — See above: MASLEN 1899 and AGNES ARBER 1914.

DESCRIPTION. — The material from coal-ball 28 consists of four strobili (figs 66-67), which have an average diameter of about 2 cm with an axis of about 3 mm in diameter. The total length could not be ascertained. The longest radial section in my collection is about 5 cm. The strobilus consists of an axis bearing crowded, spirally arranged, sporangiferous bracts, formed of a narrow, almost horizontal, pedicel, and a lanceolate, vertical limb.

XYLEM. — The xylem consists of a ring of tracheides enclosing a medulla. Whether the protoxylem forms a corona or not, I could not determine.

SPOROPHYLL-TRACE. — The sporophyll-traces branch off from the outer surface of the xylem. Through many internodes they pass from the xylem to the pedicels of the sporophylls in a steeply upward direction, but in the pedicel they assume a horizontal course (*fig. 67*). Small gaps in the outer cortex mark the passage to the pedicel of the bundles whose structure, however, has not been preserved.

SPOROPHYLL. — The p e d i c e l has an almost triangular outline when seen in tangential section. It broadens out somewhat towards the limb of the sporophyll, but never develops real wings. In transverse section the outline of the l i m b is lanceolate. Its exact dimensions and form in vertical direction could not be ascertained.

SPORANGIUM. — The sporangium is attached along the entire median line of the pedicel. The structure of the sporangium-wall could not be recognized.

The sterile pad in the sporangia described by DR. AGNES ARBER (1914, p. 208) can be observed in two beautifully preserved slides (*145/2/1-2, fig. 70*), where only the top of a strobilus is present. The normal structure of the axis of *L. oldhamius* could be seen on the outside of the block, but unfortunately it had to be lost in grinding the slides. The axis, as it now appears in the sections, seems quite different, as it is cut quite near the growing-point. As in this region the sporophylls were directed upwards, the transverse section shows a great number of pedicels and sporangia, cut more or less tangentially. In almost every sporangium the sterile tissue can be seen. It usually has the form of a cross, but the development of the horizontal arms is variable. In some sporangia they are only indicated by a swelling of the vertical bar. Towards the distal end the connection with the bottom is lost, so that only a strand parallel to the pedicel persists. It consists of a thin-walled parenchyma, which also runs along the inside of the sporangium-wall, forming a tapetum and completely surrounding the spores. The form of the spores has not been preserved.

MASLEN'S FORMS. — Though MASLEN does not very clearly describe the differences between his forms α, β, and γ, a comparison of my slides with his text and figures leads me to think, that in my material the forms α and γ are present. The strobili from coal-ball 28, figures 66 and 67, on which my description is based, I ascribe to *Lepidostrobus oldhamius* Will. *forma* α Maslen and those from coal-ball 131 and 145, figure 68, to *Lepidostrobus oldhamius* Will. *forma* γ Maslen. Figure 69 shows a beautifully preserved axis of a *Lepidostrobus* from coal-ball 40. I think that this axis should also be ascribed to *forma* γ Maslen.

The chief differences between the two forms are based on the dimensions of strobilus and axis: 2 cm and 3 mm in *forma* α against 3 cm and 4 mm in *forma* γ, and the number of leaf-traces and pedicels cut in one transverse section (Compare figures 66 and 69).

LEPIDOSTROBUS cf. FOLIACEUS Maslen.

Lepidostrobus foliaceus Maslen.

1899. M a s l e n, Trans. Linn. Soc. London, (2), Bot., V, p. 373, figs 36-39.

1907. S c o t t, Progr. Rei Bot., I, p. 169.

1908. S c o t t, Studies, 2d Ed., I, p. 187, fig. 76.

1914. A. Arber, Trans. Linn. Soc. London, (2), Bot., VIII, p. 210.

1920. Scott, Studies, 3d Ed., p. 167, figs 79-80.

1927. Hirmer, Handbuch, I, p. 230.

Lepidostrobus sp.

1893-1. Williamson, On the organization etc., XIX, p. 27, fig. 57.

1893-2. Williamson, Index, II, p. 123.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.

Loc. – Limburg: Domaniale Mijn.

England: Halifax.

DUTCH MATERIAL. — Slides 40/6/2-3.

EXTENSIVE DESCRIPTION. — See above: MASLEN 1899.

DESCRIPTION. — The preservation of the *Lepidostrobus* contained in the above-mentioned slides (fig. 71) is very poor. As the oblique direction of the sporophylls and the form of the free laminae quite agree with the figure published by MASLEN, I think it highly probable that this *Lepidostrobus* is identical with *Lepidostrobus foliaceus* Maslen. Better preserved specimens are necessary for definite identification.

LEPIDOSTROBUS BINNEYANUS A. Arber.

Lepidostrobus Binneyanus A. Arber.

1914. A. Arber, Trans. Linn. Soc. London, (2) Bot., VIII, p. 212, figs 4-8, 18-30.

1927. Hirmer, Handbuch, I, p. 230.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.

Loc. – Limburg: Domaniale Mijn.

England: Locality unknown.

DUTCH MATERIAL. — Slides 40/0/1-2, 40/2/2-7, 40/3/2.

EXTENSIVE DESCRIPTION. — See above: A. ARBER 1914.

DESCRIPTION. — The general structure of the cone is the same as in *Lepidostrobus oldhamius*. Some peculiar features shown by this specimen make it possible to refer it to *Lepidostrobus Binneyanus*. The cone is remarkably slender, about 1,5 cm in diameter, as far as it is possible to measure the badly crushed specimen, and has an axis of 3 mm in diameter.

XYLEM. — The vascular cylinder of the cone axis is nearly solid (fig. 75). Only a very small opening in the centre probably represents the pith. A protoxylem corona I could not observe.

SPOROPHYLL-TRACE. — In one of the leaf-traces the oblique downward direction in the distal portion of their course from stele to sporophyll can be observed (fig. 73). Very remarkable are the large gaps in the outer cortex through which the leaf-traces pass to the pedicel. On account of these gaps the leaf-trace is never enclosed by cortex tissue in transverse sections as is the case with *Lepidostrobus oldhamius*.

SPOROPHYLL. — The pedicel has a well-developed keel. The large-celled hypoderma described by DR. AGNES ARBER could not be recognized with certainty. The sporangium is attached to the pedicel by a stout ridge of tissue (fig. 74), possibly containing transfusion tissue. On either side of this ridge a cushion-like ridge of sclerosed tissue is present. The pedicel is provided with wings which embrace the sporangium to about half its height (fig. 74). The limb of the sporophyll is rather large. Owing to the crushing I could not ascertain its exact form and measurements.

AFFINITIES. — In several features the cone strongly resembles the strobilus of *Lepidocarpon Lomaxi* Scott (1901). Without laying undue stress on them, I would point out the following concordant characters:

a: the distinctly developed keel of the pedicel;

b: the ridge by which the sporangium is attached;

c: the ridges of sclerosed tissue on either side of the median line;

d: the wings of the pedicel, which closely resemble the integument of *Lepidocarpon Lomaxi*.

LEPIDOCARPON LOMAXI Scott.

Lepidocarpon Lomaxi Scott.

1901. Scott, Phil. Trans. Roy. Soc. London, CXCIV, B, p. 294, Pl. XXXVIII, XXXIX, XLIII.
1903. Scott, New Phyt., II, p. 19.
1907. Scott, Progr. Rei Bot., I, p. 171, fig. 11.
1908. Bower, Landflora, p. 704.
1908. Scott, Studies, 2d Ed., I, p. 194, figs 80-82.
1910. Seward, Fossil Plants, II, p. 272, fig. 218.
1920. Scott, Studies 3d Ed., I, p. 174, figs 85-87.
1921. Potonjé-Gothan, Palaeobot., p. 236, fig. 197.
1927. Hirmer, Handbuch, I, p. 328, figs 388-392.

Lepidocarpon Scott.

1900. Scott, Proc. Roy. Soc. London, LXVII, p. 306.
1909. Lotsy, Bot. Stammesgesch., II, p. 472, figs 318-319.
1925. Leclercq, Mém. in 4° de la Soc. Géol. de Belg., VI, p. 41, Pl. XXV, figs 17-19.
1927. Koopmans, Jaarverslag 1926, p. 51.

Cardiocarpon anomalum Williamson (non Carruthers).

1877. Williamson, On the organization etc., VIII, p. 254, figs 116-120.
1880. Williamson, On the organization etc., X, p. 518, fig. 64.
1900. Wild and Lomax, Ann. of Bot., XIV, p. 160.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale Mijn.
Germany: Rheinpreussen.
Belgium: Bouxharmont.
England: Dulesgate, Halifax, Oldham, Shore, Stalybridge, Strinesdale.
Hor. – Katharina.
Loc. – Germany: Vollmond, Maria.

DUTCH MATERIAL. — Very common. At least 40 specimens.

EXTENSIVE DESCRIPTION. — See above: SCOTT 1901.

DESCRIPTION. — The most interesting slides of *Lepidocarpon Lomaxi* are those numbered 96/1/2 and 96/1/3, as they contain part of a strobilus in mature condition. It is unfortunate that the axis of the strobilus is not preserved. The sections show a cluster of "seeds" (fig. 76) with their micropyles all directed towards the same point, probably the centre of the axis. The plane of section is obliquely tangential, so that the different sporophylls are cut at different distances from the axis, those in the left hand top corner of the photo being nearer to the axis than those to the right. At the proximal end the pedicel has a well-marked dorsal rib, which at the distal end merges into the thickened lamina. A single large sporangium is seated on the upper face of the sporophyll, to which it is attached all along its length. It is somewhat shorter than the sporophyll, the space enclosed by the integument being empty at the proximal end. Only the sterile pad, which has to support it, is present. All seeds are in mature condition, as the integument is fully developed. The sporangium encloses the shrivelled membrane of the megaspore, and even it has collapsed into a black triangle at the proximal end. Various details are shown better in sections of isolated megaspores, some of which have been figured. Fig. 80 shows the second one of a series of five sections cut from a single seed in parallel tangential planes. The narrow ridge of the sporangium protruding into the micropyle, the sterile tissue inside the sporangium surrounding the megaspore, and the megaspore wall are all clearly shown.

Fig. 79 shows the second section from the bottom of a series of four, cut from one seed in horizontal planes. Here also the sterile tissue is very distinct. To the left the two round dots in an oblong open space represent the vascular bundle of the sporophyll.

Fig. 77 shows a seed in naked condition. As yet the integument is only represented by two pads of dark tissue at the base of the sporangium. The megaspore wall is very distinct.

STIGMARIA FICOIDES Sternberg.

Stigmaria ficoides Sternberg.

1839. Brongniart, Archives du Museum, I, p. 426, Pl. V.
1845. Corda, Flora der Vorwelt, p. 32, Taf. XII-XIII, figs 1-8.
1869. Carruthers, Q. J. Geol. Soc., XXV, p. 248, Pl. X, figs 1-7.
1872. Williamson, On the organization etc., II, p. 216, figs 43-53.
1875. Binney, Observations, IV, p. 139, Pl. XXI, figs 1-7, Pl. XXIV, figs 1-8.
1881. Williamson, On the organization etc., XI, p. 291, figs 14-20.
1881. Renault, Cours, I, p. 155, Pl. XIX : 6.
1882. Williamson and Hartog, Ann. Sci. Nat., Bot., (6) XIII, p. 348.
1886. Felix, Abh. Geol. Spez. Karte Preussen, VII, 3, p. 38, Taf. V, fig. 1.
1887. Solms-Laubach, Einleitung, p. 277, figs 32-36.
1887. Williamson, Monograph, p. 1, Pl. IV-XI.
1899. Potonié, Pflanzenpalaeont., p. 211.
1900. Seward and Hill, Trans. Roy. Soc.Edinb., XXXIX, p. 910.
1900. Zeiller, Paléobot., p. 201.
1900. Scott, Studies, p. 221, figs 83-89.
1908. Scott, Studies, 2d Ed., I, p. 242, figs 98-105.
1909. Lotsy, Bot. Stammesgesch., II, p. 453, figs 306 : 5-9.
1910. Seward, Fossil Plants, II, p. 240, fig. 210.
1920. Scott, Studies, 3d Ed., I, p. 217, figs 107-115.
1921. Potonié-Gothan, Palaeobot., p. 230, fig. 195.
1925. Leclercq, Mém. in 4° de la Soc. Géol. de Belg., VI, p. 45, Pl. XXVI : 1-2, XXVII : 4, XXIX : 6-7, XXXI : 9, XXXII : 10, XXXIII : 11.
1927. Koopmans, Jaarverslag 1926, p. 50.
1927. Hirmer, Handbuch, I, p. 290, figs 342-348.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale Mijn.
Germany: Rheinpreusen.
Belgium: Bouxharmont, Jupille.
England: Bacup, Deighton, Dulesgate, Oldham, Shore.
Hor. – Katharina.
Loc. – Germany: Vollmond.
Stigmaria-appendices: everywhere.

DUTCH MATERIAL. — Slides from coal-balls 12, 26, 53, 54, 60, 140.

EXTENSIVE DESCRIPTION. — See above: WILLIAMSON 1887, SCOTT 1920.

DESCRIPTION. — I shall describe all subterranean organs with secondary growth of *Lepidodendron* or *Sigillaria* found in my material as belonging to the collective species *Stigmaria ficoides* Sternberg. I think it very possible that more species might be distinguished, but, as the differences are very slight, I shall join the majority of the authors who have written on this subject using only this specific name. It is quite possible that some of my specimens belong to *Stigmaria bacupensis* Scott (See LECLERCQ, 1925), but the description given by MISS LECLERCQ is too short to allow of a definite identification, nor has examination of the Belgian slides enabled me to decide with certainty (Compare fig. 93).

MEDULLA. — The centre of the stele was occupied by a fair-sized pith, of which only in some slides traces have been found attached to the wood.

XYLEM. — The wood (figs 82-84) forms a broad zone, split up into bundles by the principal medullary rays. There is no sharp distinction between primary and secondary xylem, there being no centripetal wood. The bulk of the xylem consists of radially arranged, scalariform tracheides. In addition to the principal rays, numerous secondary rays traverse the wood. As a rule they are only one cell thick; it is the exception if there are more.

PHLOEM and INNER CORTEX are not preserved.

OUTER CORTEX. — This can be observed in young Stigmarias. It consists of an irregular mass of parenchyma (fig. 84).

PERIDERM. — Periderm formation set in early. The first stage is seen in fig. 84 at the inner edge of the outer cortex. In older Stigmarias but for the wood it is the only tissue present (fig. 81).

APPENDAGES. — These are present in every slide. They usually consist of a small monarch vascular bundle, a delicate inner cortex surrounding the wood, and an outer cortex, which sometimes is connected with the inner cortex by a strand of parenchyma. Fig. 83 is a tangential section of a main axis, showing several appendage-traces on their way through the wood. These are directed with their free tips towards the growing point of the axis. The parenchyma surrounding these traces represents the principal medullary ray.

STIGMARIA ARACHNOIDEA Koopmans nov. spec.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.

Loc. – Limburg: Domaniale Mijn.

DUTCH MATERIAL. — Slides. 2/2/1, 26/1/1, 26/3/2, 26/4/1, 26/6/1-3, 51/0/1, 56/0/1-4.

DESCRIPTION. — It is not uncommon to find Stigmarian rootlets in which some of the cells of the outer cortex have been sclerosed. Sometimes these sclerosed cells form a ring on the inside of the outer cortex. In the above-mentioned slides, however, these cells form sclerotic nests, which are very regularly distributed and are very conspicuous (Figs 72, 92). They are connected by parenchymatic cells, which are tangentially elongated. The number of cells in each nest varies from 5 to 10. The structure of the xylem and of the inner cortex is that of the normal Stigmarian rootlet. In a few instances the middle cortex has been preserved as well. This consists of a thin-walled parenchyma of rather big cells.

As these rootlets are not present in any of the slides from English, German, or Belgian localities I have seen and as, to my knowledge, they have never been described or figured before, I consider it legitimate and advisable to set them apart as a separate species and to call them *Stigmaria arachnoidea*. I have chosen the name *arachnoidea*, because the sclerotic nests and the walls of the surrounding parenchyma strongly resemble black spiders in their webs.

DIPLOXYLON Corda.

DUTCH MATERIAL. — Slides 89/0/2-6, 89/1/1, 144/10/1-4, 144/11/1-4.

GENERAL REMARKS. — In two balls Lepidendroid stems are found, showing abundant secondary growth, which I cannot identify with any known species, though they are undoubtedly fragments of some *Lepidodendron* or *Lepidophloios*. As I am not convinced that they do not belong to some species described before, I have refrained from giving them new specific names and shall design them as *Diploxylon 89* and *Diploxylon 144*, using the number of the coal-ball in which they are found as a means of referring to my specimens.

DIPLOXYLON 89.

DESCRIPTION. — *Diploxylon 89* consists of a stem showing a great deal of secondary growth. Part of the medulla, the primary and the secondary wood are preserved. The primary xylem is about 2 mm thick, the secondary about 2 cm.

MEDULLA. — The pith (fig. 88) is poorly preserved. Some traces of cellular tissue are present. As far as could be made out, this tissue was entirely parenchymatous without any isolated tracheides.

XYLEM. — While the protoxylem (fig. 88) is poorly preserved, it seems not improbable that a corona is present, though less developed than in *Lepidophloios laricinus*. The metaxylem consists of a ring of large scalariform tracheides. The main body is about 10 tracheides broad. On the outside, the large ones give place to a narrow belt of much smaller tracheides. The secondary xylem (figs 87, 88) consists of very regular radial rows of scalariform tracheides. Those quite near to the protoxylem are rather small, but they soon become bigger, till their diameter is about the same as that of the metaxylem elements. Their outline is almost square. At several places the radial rows are interrupted by very curious groups of small tracheides (fig. 87.). These groups do not represent leaf-traces, as in tangential section the latter are shown to consist of mesarch groups of still smaller tracheides, which have apparently a strictly horizontal course. No free leaf-traces have been observed. The numerous medullary rays are one cell wide and of variable height.

Phloem, cortex, and leaf-bases are not preserved.

DIPLOXYLON 144.

DESCRIPTION. — *Diploxylon 144* consists of fragments of the wood and the periderm of a large stem (fig. 85.). The complete measurements of this stem cannot be ascertained.

XYLEM. — Both primary and secondary xylem are present (fig. 86). The primary xylem consists of a zone of large, scalariform tracheides, irregularly arranged, 3 mm thick, and about 13 elements broad. The secondary xylem consists of a zone of somewhat smaller, scalariform tracheides, radially arranged, 5 mm thick, and about 40 elements broad. The protoxylem is represented by small groups of tracheides, which do not form a well-marked corona.

LEAF-TRACE. — It is a curious feature of this stem that no leaf-traces have been observed, either in transverse, or in tangential sections.

PERIDERM. — The periderm (fig. 85) is the only tissue present outside the wood. It has been abundantly developed and forms a zone of about 18 mm thick, consisting of small cells, which in transverse section are about square, and in tangential and radial section somewhat rectangular. On the outside it has split up into a great number of thin lamellae.

SIGILLARIA cf. ELEGANS Brongniart.

Sigillaria elegans Brongniart.

1905. Kidston, Trans. Roy. Soc. Edinb., XLI, 3, p. 533-550, Pl. I-III.
1908. Scott, Studies, 2d Ed., I, p. 228.
1910. Seward, Fossil Plants, II, p. 221, figs 193D, 202A.
1920. Scott, Studies, 3d Ed., I, p. 205.
1927. Hirmer, Handbuch, I, p. 27, figs 319-322.

Sigillaria sp.

1927. Koopmans, Jaarverslag 1926, p. 50.

Compare also:

Sigillaria scutellata Brongniart.

1907. Kidston, Proc. Roy. Soc. Edinb., XXVII, 3, p. 205, fig. 2.

1909. Arber and Thomas, Phil. Trans Roy. Soc. London, CC, p. 139, Pl. XIV.

Sigillaria mamillaris Brongniart.

1907. Kidston, Proc. Roy. Soc. Edinb., XXVII, 3, p. 203, fig. 1.

Sigillaria Boblayi Brongniart.

1909. Zalessky, Mem. Imp. Russ. Min. Soc., XLVI, 2, p. 305, Pl. VIII-X.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.

Loc. – Limburg: Domaniale Mijn.

England: Huddersfield, Shore.

DUTCH MATERIAL. — Slides 64/0/1-3, 64/1/1-2.

EXTENSIVE DESCRIPTION. — See above: KIDSTON 1905.

DESCRIPTION. — The Dutch specimen consists of a small portion of the woody cylinder with which a piece of bark is associated. The coal-ball in which it occurs, is only a very small one so that there is no chance of larger remains being found in other slides from this ball.

PRIMARY XYLEM. — The primary xylem (fig. 33) is about 0,8 mm thick. The outer surface is strongly and regularly undulate, so as to form a number of blunt ridges alternating with as many furrows. The inner surface of the primary xylem is undulate, too, but not as regularly as the outer surface. The main mass of the primary xylem consists of large tracheides, more or less hexagonal in transverse section, and without any intervening parenchymatous cells. They diminish slightly and gradually in size towards the outside, but just underneath the ridges a decrease in size takes place somewhat abruptly, and the ridges themselves are composed of much narrower elements, which are regarded as constituting the protoxylem. Radial sections show that the elements of the metaxylem are elongated, scalariform tracheides. So far as was observed, no spiral or annular elements are found at any point in the primary xylem, not even in the protoxylem.

SECONDARY XYLEM. — This forms a zone of about 0,7 mm thick. Its inner surface follows the crenulate outline of the primary xylem, and the outer surface exhibits the same structure. The tracheides of the secondary xylem are arranged in radial rows, interspersed at intervals with medullary rays, which run uninterruptedly through the whole thickness of the secondary wood. Longitudinal sections of the stele show that the tracheides of the secondary xylem are elongated and scalariform with pointed edges, similar to those of the main body of the primary xylem, but only somewhat smaller in diameter. The tracheides are of uniform size throughout the secondary xylem, there being no difference between those opposite the ridges and those opposite the furrows. At the ridges only the primary and the secondary xylem are in direct contact. In the furrows a black line intervenes between the primary xylem and the inner tracheides of the secondary xylem. This line probably consists of collapsed thin-walled cells.

LEAF-TRACE. — The leaf-traces arise from the periphery of the primary xylem at the base of the furrows. When the leaf-trace becomes free from the metaxylem it consists of a group of about a dozen small tracheides, arranged radially around the smallest of them. The structure is distinctly mesarch. By the time the leaf-trace emerges from the secondary wood, one or two rows of tracheides have been added, mostly on the side near the axis. In leaf-traces, which are quite free from the axis, the number of tracheides is still greater. The course of the leaf-traces through the xylem could not be followed.

CORTEX. — A piece of cortex was found associated with the wood. The only part of it which is preserved is that formed by a portion of the ribs and the underlying periderm. In transverse section the periderm consists of very small cells placed in radial rows. The main body of the rib consists of fairly thick-walled parenchyma. In the cortex no leaf-traces are seen.

SIGILLARIAN LEAF-BASES.

DUTCH MATERIAL. — Coal-balls 3, 27, 82, 85, 92, 95, 96, 126, and slides cut from these balls.

DESCRIPTION. — In the above-mentioned balls isolated leaf-bases of *Sigillaria* are present. I have

not been able to decide with sufficient certainty to what species these remains belong. I think it probable that at least two species are present.

Coal-ball 27 contains several layers of bark of a *Sigillaria*. On the outside of the ball the impression of the leaf-bases is shown. (fig. 96.) According to DR. W. J. JONGMANS this impression probably belongs to *Sigillaria mamillaris* Brongniart. (Compare DELTENRE 1926, Pl. XIV.) Unfortunately no wood has been preserved.

Associated with these leaf-bases are found *Mazocarpon cf. shorense* Benson (see below) and *Sigillariopsis laevis* Koopmans (see below).

SIGILLARIOPSIS LAEVIS Koopmans nova spec.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.

Loc. – Limburg: Domaniale Mijn.

DUTCH MATERIAL. — Slides 27/0/2-5, 27/1/1, 27/2/1-2, 27/6/1-6.

DESCRIPTION. — In coal-ball 27 numerous leaves are found closely associated with leaf-cushions of *Sigillaria mamillaris* (see above). The preservation is not very good, but in all specimens the double vascular bundle, characteristic of *Sigillariopsis*, is clearly shown (fig. 94). Only the xylem has been preserved, the softer tissues, i. e. the phloem and the secretory tissue, having disappeared. The transfusion-tissue partly surrounds the bundle, leaving a gap between the xylem groups as in *Sigillariopsis sulcata*. The main body of the leaf consists of an irregular parenchyma, while, beneath the upper face traces of palissade parenchyma are present. The only important differences with *Sigillariopsis sulcata* Scott (1904-1) are the total absence of the stomatiferous furrows and the presence of a distinct keel on the dorsal face of the leaf. I, therefore, regard the Dutch specimens as a distinct species and propose the name *Sigillariopsis laevis*, as the absence of the furrows makes the surface quite smooth.

MAZOCARPON cf. SHORENSE Benson.

Mazocarpon shorense Benson.

1918. B e n s o n, Ann. of Bot., XXXII, p. 569, Pl. XVII-XVIII, 4 textfigs.

1920. S c o t t, Studies, 3d Ed., I, p. 213, figs 103-106.

1927. H i r m e r, Handbuch, I, p. 284, figs 333-335.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.

Loc. – Limburg: Domaniale Mijn.

Germany: Rheinpreussen.

England: Bacup, Deighton, Dulesgate, Halifax, Shore, Stalybridge.

DUTCH MATERIAL. — Slide 27/0/2 and many isolated spores in other slides.

EXTENSIVE DESCRIPTION. — See above: BENSON 1918.

DESCRIPTION. — In many slides there are present isolated megaspores bearing a strong resemblance to those published of *Mazocarpon shorense*. The figured slide (figure 95) contains a sporangium, in which four megaspores are seen. The sterile central pad consists of parenchymatic tissue. The sporangial wall has been preserved but does not show any structure. Traces of a tapetum can be recognized.

This sporangium has been found closely associated with *Sigillariopsis laevis* (see above) and with leaf-bases of *Sigillaria mamillaris* (see above).

SPHENOPHYLLUM PLURIFOLIATUM Williamson et Scott.

Sphenophyllum plurifoliatum Williamson et Scott.

1894. W i l l i a m s o n a n d S c o t t, Further observations, I, p. 920, photographs 19-22, figs 40-44A.

1898. Seward, Fossil Plants, I, p. 397, figs 105A, B, D, 106.
1900. Zeiller, Paléobot., p. 141, fig. 102.
1908. Scott, Studies, 2d Ed., I, p. 89, figs. 37-39.
1920. Scott, Studies, 3d Ed., I, p. 78. figs. 39-41.
1921. Potonié-Gothan, Palaeobot., p. 152, fig. 130.
1925. Leclercq, Mém. in 4° de la Soc. Géol. de Belg., VI, p. 31, Pl. XI, fig. 1, Pl. XII, fig. 4.
1927. Koopmans, Jaarverslag 1926, p. 50.
1927. Hirmer, Handbuch, I, p. 349, figs 405-409, 411.

Sphenophyllum sp.

1886. Felix, Abh. Geol. Spez. Karte Preussen, VII, 3, p. 42, Taf. VI, figs 1-7.

Asterophyllites sphenophylloides Williamson.

1874. Williamson, On the organization etc., V, p. 42, figs 1-17.
1878. Williamson,, On the organization etc., IX, p. 332, fig. 32.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale Mijn.
Germany: Rheinpreussen.
Belgium: Bouxharmont.
England: Deighton, Dulesgate, Halifax, Oldham, Shore, Stalybridge.
Hor. – Katharina.
Loc. – Germany: Maria, Vollmond.

DUTCH MATERIAL. — Slides 27/0/1, 4-11, 28/2/1bis-2bis, 28/9/1, 102/1/1-2, 102/2/1-3, 102/3/2-3, 102/4/1-3.

EXTENSIVE DESCRIPTION. — See above WILLIAMSON and SCOTT 1894.

DESCRIPTION. — The best preserved specimen is contained in coal-ball 27. It is found closely associated with *Sphenophyllostachys Dawsoni.* (See p. 24) The xylem is beautifully preserved and is surrounded by partly preserved periderm.

XYLEM. — The primary xylem, when seen in transverse section, is triangular (figs 100-104). The sides of the triangle are somewhat concave, and the angles are slightly truncated. The xylem is a solid mass of tracheides; there is no trace either of a medulla or of xylem-parenchyma. The tracheides near the middle of the stele are of large size, but towards the three prominent angles their size rapidly diminishes, and at the extreme ends the elements constituting the protoxylem are of very small diameter.

Secondary xylem. — As there is a distinct difference between the wood formed between the protoxylem groups and that which is formed opposite them, I shall use the terms proposed by WILLIAMSON and SCOTT (1894) viz.: interfascicular and fascicular wood. The large elements of the interfascicular wood, which in transverse section appear to be almost square, often having truncated corners, are arranged in straight radial rows. Their radial walls are marked by numerous small pits. Between the corners of the tracheides parenchymatous cells are found, occupying the space left by their truncated corners. Occasionally one of these cells appears in each space in transverse sections; more often they occur in small groups. As is seen in tangential section, these parenchymatous cells, which form longitudinal strands of considerable length, are connected by isolated cells with a radiate arrangement. The elements of the fascicular wood are also arranged in regular rows, which, however, diverge fan-wise from the protoxylem groups. Nearer to the edge of the wood their course becomes radial. It is sharply differentiated from the interfascicular wood by the much smaller dimensions of the elements. This distinction, however, tends to disappear in the outer part of the wood. According to WILLIAMSON and SCOTT (1894) real medullary rays are present, but I have not been able to verify this in my slides.

WILLIAMSON and SCOTT (1894) suggest the possibility that the secondary wood consists of real vessels and not of tracheides. SCOTT in 1920 simply states this as a fact, and with this I do not agree. In

not a single longitudinal section remains of transverse walls have been observed as yet. The study of a series of five consecutive transverse sections has shown some very remarkable radial walls, which are only to be accounted for as sections of a very oblique wall, i.e. the wall between the pointed ends of two tracheides. Figs 100-104 give an idea of the way in which these walls change their place in successive sections. I, therefore, think that the secondary wood also consists of pointed tracheides of considerable length, which are separated by oblique radial walls.

SOFT TISSUES. — In several slides the wood is surrounded by some layers of small cells arranged radially, which probably represent the periderm. The preservation does not allow of a description of any value.

SPHENOPHYLLUM MINUS Koopmans nova spec.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale Mijn.
Germany: Rheinpreussen.

DUTCH MATERIAL. — Slides 40/0/6-9.

DESCRIPTION. — The general structure of this stem (fig. 99) closely resembles that of *Sphenophyllum plurifoliatum*. The chief distinctions are:

a. The difference in size between the masses of primary xylem: The distance between two protoxylem groups in this species is only 0,4 mm, whereas it is more than 1 mm in the figures of *Sphenophyllum plurifoliatum* and also in my own specimens.

b. The surface of the metaxylem is less concave than in *Sphenophyllum plurifoliatum*.

c. The rows of the fascicular xylem are almost straight; the fan-like divergence is practically non-existent.

d. The earliest formed cells of the interfascicular xylem are much smaller than in *Sphenophyllum plurifoliatum*.

Comparison of figures 99 and 104, which are both magnified 25 times, clearly shows these differences, which seem to be sufficiently important to justify specific distinction.

SPHENOPHYLLUM PERFORATUM Koopmans nova spec.

Sphenophyllum sp. 1927. K o o p m a n s, Jaarverslag 1926, p. 51.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale Mijn.
Hor. – Katharina.
Loc. – Germany: Maria.

DUTCH MATERIAL. — Slides 145/0/1-4, 145/1/1, 145/2/1-4, 155/4/1-4.

DESCRIPTION. — The general structure of this species (fig. 98) agrees closely with that of *Sphenophyllum plurifoliatum:* a triarch primary wood enclosed by a zone of secondary xylem. The structure of the medullary system is identical. There are no medullary rays but clusters of cells occur at the corners of the secondary tracheides.

The most important character of this new species is the presence of canals in the protoxylem-region, such as we know hitherto only from the Lower Carboniferous *Sphenophyllum insigne*. The discovery of this occurrence in Coal-Measure species therefore constitutes a new record.

The second character in which this species differs from *S. plurifoliatum* is the fact that the diameter of the metaxylem elements is much smaller in the new species.

The third distinction is that the outline of the primary wood is somewhat different: the arms are more pronounced, and the central mass of tracheides is smaller than in *S. plurifoliatum* (Compare figures 98 and 104).

The wood is enclosed by a ring of radially arranged elements, which are not well preserved. Probably this ring represents the periderm.

As the presence of protoxylem-canals precludes identification with *Sphenophyllum plurifoliatum*, and as the structure of the medullary system precludes identification with *Sphenophyllum insigne*, I propose to recognize this stem as a separate species and to call it: *Sphenophyllum perforatum*.

SPHENOPHYLLOSTACHYS DAWSONI (Williamson) Seward.

Sphenophyllostachys Dawsoni (Williamson) Seward.

1898. Seward, Fossil Plants, I, p. 402, figs 107A-G, 108.

1910. Seward, Fossil Plants, II, p. 1, figs 112, 116.

1927. Hirmer, Handbuch, I, p. 355, figs 416-420.

Volkmannia Dawsoni Williamson.

1871. Williamson, Mem. Proc. Lit. Phil. Soc. Manch., V, p. 28, Pl. I-III.

1874. Williamson, On the organization etc., V, p. 53, figs 28-30.

Bowmanites Dawsoni Williamson.

1890. Williamson, On the organization etc., XVII, p. 99, fig. 19.

1891. Williamson, On the organization etc., XVIII, p. 255, figs 1-18.

1893. Zeiller, Mém. Soc. Géol. France, Paléont., No. 11, p. 5, figs A-G.

Sphenophyllum Dawsoni (Williamson) Williamson et Scott.

1894. Williamson and Scott, Further observations, I, p. 933, photo 25-26, figs 54-58.

1897. Scott, Phil. Trans. Roy. Soc. London, B, CLXXXIX, p. 23.

1899. Potonié, Pflanzenpalaeont., p. 179, fig. 177.

1905. Scott, Phil. Trans. Roy. Soc. London, B, CXCVIII, p. 33.

1906. Thoday, New Phyt., V, p. 91, fig. 14.

1907. Scott, Progr. Rei Bot., I, p. 151, fig. 1.

1908. Scott, Studies, 2d Ed., I, p. 99, figs 41-44.

1908. Bower, Landflora, p. 403, fig. 219.

1909. Lotsy, Bot. Stammesgesch., II, p. 525.

1920. Scott, Studies, 3d Ed., I, p. 88, figs 44-47.

1921. Potonié-Gothan, Palaeobot., p. 153.

1925. Leclercq, Mém. in 4° de la Soc. Géol. de Belg., VI, p. 34, Pl. XII, fig. 5, Pl. XIII, fig. 6.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.

Loc. – Limburg: Domaniale Mijn.

Germany: Rheinpreussen.

Belgium: Bouxharmont.

England: Bacup, Halifax, Huddersfield, Oldham, Shore, Stalybridge.

DUTCH MATERIAL. — Slides 27/6/1-5.

EXTENSIVE DESCRIPTION. — See above: WILLIAMSON and SCOTT 1894.

DESCRIPTION. — The specimen consists of a small part of a strobilus about 1 cm long, which is cut into five successive almost tangential slides. The section figured is the middle one and nearly radial (fig. 97). Five whorls of sporangia are present. In the figured slide the lowest is represented by one sporangium only. As the ball in which the specimen was found is very badly pyritized, the preservation is not good. The axis and the sporophylls are represented for the greater part by a structure-less mass, in which here and there traces of tracheides and parenchyma can be recognized. Of the sporangiophores, nothing is left which can be recognized as such with certainty. The sporangial wall consists of one row of small cells. The sporangia are

filled with a dense mass of badly preserved spores. The characteristic sculpturing of the spore-membrane has disappeared, only the prominent spines are preserved in some of them.

I am not sure whether this specimen represents the α or the β form of SCOTT (1920), or whether it may be a γ -form, as it is narrower than the α -, but broader than the β -form. The preservation does not allow of any definite decision.

The strobilus is found closely associated with the stem of *Sphenophyllum plurifoliatum* (see pag. 21, and figs 100-104.)

ROOTS OF SPHENOPHYLLUM.

DESCRIPTION. — In several slides small roots are found, which agree closely with the descriptions and the figures given of the root of *Sphenophyllum*. As in all specimens the preservation is not good, it is deemed unnecessary to give a description or a figure. In addition no other root exists for which it might be mistaken and identification with a definite stem of *Sphenophyllum* is impossible, as it is found associated with all three species of *Sphenophyllum* present in the Dutch material.

CALAMITES COMMUNIS [Binney (non Ettingshausen)] Seward.

Calamites communis [Binney (non Ettingshausen)] Seward.

1898. Seward, Fossil Plants, I, p. 312, figs 74A, 75-76.

Calamodendron commune Binney (non Ettingshausen).

1868. Binney, Observations, I, p. 19, Pl. II-III.

Arthropitys communis [Binney (non Ettingshausen)] Renault.

1876. Renault, C. R. Ac. Sci. Paris, LXXXIII, p. 574.

Calamites species.

1871. Williamson, On the organization, I, p. 477, Pl. XXIII-XXIX.

1894. Williamson and Scott, Further observations, I, p. 863, Pl. LXXII-LXXIII, LXXVII-LXXX.

The complete synonymy of this species is given in:

1915. Jongmans, Fossilium Catalogus, Plantae, 5, p. 245. *(Calamites communis)*, p. 418 *(Calamites species)*.

1924. Jongmans, Ibid., Plantae, 11, p. 769, 780.

On the leaves of *Calamites (Calamocladus* sive *Asterophyllites)* see:

1911. Thomas, Phil. Trans. Roy. Soc. London, B, CCII, p. 51, Pl. III-V, 13 textfigs.

1920. Scott, Studies, 3d Ed., I, p. 33, figs 12-15.

On the roots of *Calamites* [*Astromyelon Williamsonis* (Cash and Hick) Williamson] see:

Astromyelon Williamsonis (Cash and Hick) Williamson.

1883. Williamson, On the organization, XII, p. 459, figs 1-14.

1886. Felix, Abh. Geol. Spezialk. Preussen, VII, 3, p. 48.

1895. Williamson and Scott, Further observations, II, p. 683, Pl. XV-XVII.

1914. Jongmans, Fossilium Catalogus, Plantae, 4, p. 165.

Myriophylloides Williamsonis Cash and Hick.

1881. Cash and Hick, Proc. Yorks. Geol. Polyt. Soc., VII, 4, p. 400.

Helophyton Williamsonis (Cash and Hick) Williamson.

1881. Williamson, Nature, Dec. 8, p. 124.

Astromyelon species.

1878. Williamson, On the organization, IX, p. 319, Pl. XIX, figs 1-7.

1898. Seward, Fossil Plants, I, p. 342, figs 90-92.

Root of Calamites.

1871. Williamson, On the organization, I, p. 487, figs 16, 39.

1903. Stopes, Ann. of Bot., XVII, p. 792, figs 30-32.

1908. Scott, Studies, 2d Ed., I, p. 41, figs 15-16.

1920. Scott, Studies, 3d Ed., I, p. 39, figs 16-17.

1925. Leclercq, Mém. in 4° de la Soc. Géol. de Belgique, VI, p. 25, Pl. III, fig. 6.

DISTRIBUTION. — Everywhere.

DUTCH MATERIAL. — Very common. At least 30 specimens.

EXTENSIVE DESCRIPTION. — See above: WILLIAMSON 1871, WILLIAMSON and SCOTT 1894. Compare also SEWARD 1898, SCOTT 1920.

DESCRIPTION. — Stems of *Calamites* are fairly abundant in the Dutch material. The structure of these stems has been described several times, but there has been very little systematic investigation. Although I think that several distinct species are present in my slides, I prefer to name them all provisionally *Calamites communis*. My description will, therefore, contain only those characters in which they all agree.

MEDULLA. — The pith is hollow (fig. 105), except at the nodes, where a diaphragm is found.

XYLEM. — Around the pith there is a ring of collateral vascular bundles. In place of the protoxylem a gap is found, caused by the disorganisation of this tissue. The vascular bundles are separated by the principal medullary rays, which are very wide in the vicinity of the medulla, but soon diminish in width. A layer of secondary wood of varying thickness is present in all specimens.

ROOTS. — In several slides roots have been observed. They are distinguished from the stem by the absence of protoxylem canals and the presence of a solid pith. It was not possible to recognize with certainty, whether or not the primary wood is centripetal.

CALAMOSTACHYS BINNEYANA (Carruthers) Schimper.

Calamostachys Binneyana (Carruthers) Schimper.

1869. Schimper, Traité, I, p. 330, Pl. XXIII, figs 5-10.

1874. Williamson, On the organization, V, p. 58, figs 33-43.

1880. Williamson, On the organization, X, p. 502, figs 13-18.

1881. Williamson, On the organization, XI, p. 298, figs 23-27.

1881. Saporta et Marion, Evol. Crypt., p. 135, figs 55C-D.

1884. Weiss, Steink. Calamarien, II, Abh. Geol. Spezialk. Preussen, V, 2, p. 169, Taf. XXI, fig. 7.

1886. Felix, Abh. Geol. Spezialk. Preussen, VII, 3, p. 48.

1887. Cash, Proc. Yorks. Geol. Polyt. Soc., IX, p. 449, Pl. XXII, XXIII, XXVI.

1889. Williamson, On the organization, XV, p. 160, figs 7-8.

1891. Williamson, Index, I, p. 14.

1894. Williamson and Scott, Further observations, I, p. 901, Pl. LXXIII-LXXIV, figs 10-16, Pl. LXXX, figs 23-26, Pl. LXXXI-LXXXII.

1898. Seward, Fossil Plants, I, p. 351, figs 94-95.

1900. Scott, Studies, p. 45, figs 16-22.

1906. Felix, Leitfossilien, p. 21, fig. 31C.

1908. Bower, Landflora, p. 408, fig. 225.

1908. Scott, Studies, 2d Ed., I, p. 50, figs 17-23.

1909. Thomas, New Phyt., VIII, p. 249, Pl. I, textfigs 31-32.

1909. Lotsy, Bot. Stammesgesch., II, p. 539, figs 361 : 1-3.

1910. Hickling, Mem. Proc. Lit. Phil. Soc. Manch., LIV, 3, 17, p. 1. 1 Pl., 3 textfigs.
1911. Jongmans, Anleitung, I, p. 313, fig. 271.
1915. Jongmans, Fossilium Catalogus, Plantae, 7, p. 476.
1920. Scott, Studies, 3d Ed., I, p. 45, figs 18-23.
1921. Potonié-Gothan, Palaeobot., p. 177.
1925. Leclercq, Mém. in 4° de la Soc. Géol. de Belg., VI, p. 26, Pl. IX, fig. 13, Pl. X, fig. 15.
1927. Koopmans, Jaarverslag 1926, p. 50.
1927. Hirmer, Handbuch, I, p. 401, figs 480-484, 488.

Volkmannia Binneyi Carruthers.

1867. Carruthers, Journal of Botany, V, p. 349, Pl. 70.

Calamites Binneyi Carruthers.

1869. Carruthers, Cryptog. Forests, Roy. Instit. Great Brit., Weekly evening meeting 16 April, p. 7, Pl. II, figs 7-11.
1872. Balfour, Introduct. Palaeontol. Bot., p. 60, fig. 47 : 7-11.

Bruckmannia Binneyana (Carr.) Renault.

1882. Renault, Cours, II, p. 136.

Calamodendron commune Binney.

1868. Binney, Observations, I, p. 23, Pl. IV-V.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale Mijn.
Germany: Rheinpreussen.
Belgium: Bouxharmont.
England: Dulesgate, Halifax, Huddersfield, Oldham, Shore, Stalybridge. Strinesdale.
Hor. – Katharina.
Loc. – Germany: Maria.

DUTCH MATERIAL. — Coal-ball 17, 28, 56, 76, 80, 91, 96, 98, 102, 127, and slides cut from these balls.

EXTENSIVE DESCRIPTION. — See above: WILLIAMSON and SCOTT 1894, HICKLING 1910.

DESCRIPTION. — The strobilus is one of the commonest plant-remains contained in the Dutch material (fig. 107). Unfortunately the preservation is never very good. The structure of the xylem is shown in none of the specimens, but still it is possible to recognize that it is triarch in some and tetrarch in others. The cone consists of an axis to which are attached whorls of sporangiophores, alternating with whorls of sterile bracts. The horizontal parts of the bracts are coherent, forming a disc. The vertical limbs are free. The whorls of sporangiophores are midway between those of the sterile bracts, the number of the former in each whorl being about half the number of the latter — as a rule they are six and twelve respectively. Each peltate sporangiophore bears four elongated sac-like sporangia, which, in tangential section, surround the stalk of the sporangiophore. Only microspores have been observed.

CALAMOSTACHYS OLDHAMIA Hick and Lomax.

Calamostachys oldhamia Hick and Lomax.

1894. Hick and Lomax, Mem. Proc. Lit. Phil. Soc. Manch., (4) VIII, 8 pp., 4 figs.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale mijn.
England: Oldham.

DUTCH MATERIAL. — Slides 89/0/5-6.

DESCRIPTION. — Slide 89/0/5 contains only the tips of some of the bracts. Slide 89/0/6 is a section through the strobilus, partly radial, partly tangential. The general morphology of this strobilus is quite the same as in *C. Binneyana*, as is shown in fig. 106. It consists of an axis bearing whorls of sterile bracts and of fertile sporangiophores, to which are attached four sporangia. The diameter of this cone, however, is twice that of *C. Binneyana:* 9-10 mm against 4-5 mm. This diameter and also the form of the bracts agreeing with the text and figures of HICK and LOMAX (1894), I think it highly probable that this specimen should be identified with *Calamostachys oldhamia* Hick and Lomax.

PALAEOSTACHYA VERA Seward.

Palaeostachya vera Seward.

1898. Seward, Fossil Plants, I, p. 358, fig. 98.
1900. Scott, Studies, p. 61, fig. 25.
1907. Hickling, Ann. of Bot., XXI, p. 369, Pl. XXXII-XXXIII, 4 textfigs.
1908. Bower, Landflora, p. 375, fig. 203.
1908. Scott, Studies, 2d Ed., I, p. 64, figs 26-27.
1920. Scott, Studies, 3d Ed., I, p. 56, figs 27-28.
1922. Jongmans, Fossilium Catalogus, Plantae, 9, p. 651.
1927. Hirmer, Handbuch, I, p. 405, figs 489-490.

Calamitean strobilus.

1870. Williamson, Mem. Proc. Lit. Phil. Soc. Manch., (3) IV, p. 248, Pl. VII-IX.

True fructification of Calamites.

1887. Williamson, On the organization, XIV, p. 47, Pl. 8-11.

Calamites pedunculatus Williamson and Scott (non Williamson) (Diagn. in: Weiss 1884).

1894. Williamson and Scott, Further observations, I, p. 916.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale mijn.
England: Oldham, Strinesdale.

DUTCH MATERIAL. — Slides 60/0/2-3, 98/5/1, 98/6/1.

EXTENSIVE DESCRIPTION. — See above: HICKLING 1907.

DESCRIPTION. — The preservation of the two Dutch specimens is so poor that hardly any cells can be recognized. Nevertheless there is no doubt but both specimens belong to this species.

SPECIMEN I. Slides 98/5/1 and 98/6/1. Fig. 109. — Only the sclerosed tissue surrounding the vascular bundles, parts of the sclerenchyma of the bracts, a few traces of the subepidermal sclerenchyma, and the tips of some of the bracts (not shown in the photo) have been preserved. The sixteen protoxylem canals, arranged in pairs, are very clearly shown. The structure of the vascular bundles is not preserved.

SPECIMEN II. Slides 60/0/2 and 60/0/3. Fig. 108. — Slide 60/0/2 contains only the tips of some of the bracts. Slide 60/0/3 is more complete. In the centre the sclerosed tissue surrounding the vascular bundles is seen. As this ring has 8 protuberances, there must have been 16 protoxylem canals, but these have not been preserved. Traces of the sub-epidermal sclerenchyma are present. The structure-less mass of spores is divided by thin black lines: the sporangia walls, and the sporangiophores are represented by black dots. On the outside some of the bracts are seen. The number of these appendages appears to have been equal to that of the sporangiophores, i. e. sixteen.

It is very curious that the sporangiophores alternate with the bracts! This is not a peculiarity of this slide only, but it is also clearly shown in the textfigures of HICKLING'S memoir (1907) and in fig. 27 of SCOTT (1920). It is quite the reverse of the generally accepted opinion that the sporangiophores spring from the axils of the bracts. I have not been able to find a satisfactory explanation.

ETAPTERIS SCOTTI P. Bertrand.

Etapteris Scotti P. Bertrand.

1907. P. Bertrand, C. R. Acad. Sci. Paris, CXLV, p. 776.
1909. P. Bertrand, Zygopterid., p. 140, 208, textfigs 20-21, Pl. XVI, figs 111-112.
1910. Seward, Fossil Plants, II, p. 462, fig. 308B.
1920. Scott, Studies, 3d. Ed., I, p. 320, fig. 143.
1924. Posthumus, Rec. Trav. Bot. Néerl., XXI, p. 179, fig. 11.
1925. Leclercq, Mém. in 4° de la Soc. Géol. de Belg., VI, p. 51, Pl. XXXV, fig. 1, XXXVI, fig. 3.
1926. Posthumus, Foss. Catal., Plantae, 12, p. 33.
1927. Koopmans, Jaarverslag 1926, p. 50.
1927. Hirmer, Handbuch, I, p. 506, figs 607-610.

Zygopteris Lacattei Binney (non Renault).

1872. Binney, Mem. Proc. Lit. Phil. Soc. Manch., XII, p. 99.
1872. Williamson, Proc. Roy. Soc. London, XX (136), p. 436.
1889. Williamson, On the organization etc., XV, p. 159, fig. 6.

Rachiopteris Lacattei [Binney (non Renault)] Williamson.

1874. Williamson, On the organization etc., VI, p. 693, figs 42-48.
1885. Felix, Ber. Naturforsch. Ges. Leipzig, p. 10.
1886. Felix, Abh. Geol. Spezialk. Preussen, VII, 3, p. 10, Taf. I, fig. 1.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale mijn.
Germany: Rheinpreussen.
Belgium: Bouxharmont.
England: Deighton, Dulesgate, Halifax, Oldham, Shore, Stalybridge.
Hor. – Katharina.
Loc. – Germany: Vollmond, Maria.

DUTCH MATERIAL. — Slides 5/1/1-2, 5/3/1-3, 5/4/1-2, 28/8/3-4, 28/9/2, 68/0/1-3, 81/0/1, 102/3/1-3, 127/1/1-3, 127/4/3, 141/2/1, 145/0/1-4, 147/0/2-3, 152/1/1, and block 162.

EXTENSIVE DESCRIPTION. — See above: BERTRAND 1909.

DESCRIPTION. — Petioles of this species are fairly common. In outline they are elliptical.

XYLEM. — The xylem (figs 113, 114, 123) has the well-known form of a double anchor. The middle band consists of large reticulate tracheides and is somewhat swollen in the centre. At both ends two club-shaped arms are inserted, which are thinnest, where they join the middle bar of xylem and become broader near their free ends. The arms consist in the main of large tracheides, but on the outside there are one or two rows of smaller elements, which, however, are not separated from the larger ones by parenchyma, as is the case in *Ankyropteris*. The protoxylem is represented by a group of small tracheides on the outside of each of the arms near the insertion.

PINNA-TRACES. — These branch off in pairs from the protoxylems, alternately to the left and to the right. The two traces from each pair soon unite to the "pinna-bar", but separate again when, on its outgoing course, this pinna-bar reaches the cortex. In the cortex each trace is divided into two parts, viz. the leaf-trace and the much smaller aphlebia-trace (fig. 113).

PHLOEM. — This is not preserved.

CORTEX. — The cortex consists of two zones, an inner zone of fairly large cells and an outer zone of very small sclerosed ones. They are arranged in vertical rows and separated by horizontal walls. Those

on the inside are about as high as they are broad, but their length increases as their diameter decreases, so that those on the outside may be ten times as long as those on the inside.

VARIATIONS. — Several slight variations have been observed. Sometimes the middle bar of the xylem is quite straight; sometimes the arms are more slender than those of the type-specimen, with which the specimen from coal-ball 28, fig. 113, quite agrees; sometimes the insertion of the arms seems to be different. Prof. PAUL BERTRAND who was so kind as to examine my slides, quite shared my opinion that as yet it is better to attach no specific value to these minor variations. I have examined at Liége the slides, which MISS LECLERCQ (1925) ascribes to *Etapteris Lacattei*, but at present I regard this specimen also as one of these variations, though I allow the possibility that it may belong to some species not yet described. Perhaps they are not variations at all, but only differences depending on the distance from the base of the petiole (comp. figs 113-114, 123).

ANKYROPTERIS WESTPHALIENSIS P. Bertrand.

Ankyropteris westphaliensis P. Bertrand.

1909. P. Bertrand, Zygopterid., p. 73.
1912. P. Bertrand, Progr. Rei Bot., II, p. 226, fig. 18.
1920. Scott, Studies, 3d Ed., I, p. 298, fig. 135.
1924. Posthumus, Rec. Trav. Bot. Néerl., XXI, p. 187, figs 14-16.
1925. Leclercq, Mém. in 4° de la Soc. Géol. de Belg., VI, p. 53, Pl. XXXVIII, fig 5, Pl. XXXIX, fig. 6.
1926. Posthumus, Foss. Catalogus, Plantae, 12, p. 17.
1927. Hirmer, Handbuch, I, p. 522, figs 637-639.

Ankyropteris bibractensis (Renault) P. Bertrand *var. westphaliensis* P. Bertrand.

1909. P. Bertrand, Zygopterid., p. 71, 219, figs 60-65, 68-77, textfigs 9-11, 23b, 24.
1910. Seward, Fossil Plants, II, p. 454, figs 312C, 313.

Rachiopteris bibractensis Williamson (non Renault).

1874. Williamson, On the organization etc., VI, p. 697, figs 49-50.

Zygopteris bibractensis [Williamson (non Renault)] Scott.

1900. Scott, Studies, p. 286, fig. 99.
1907. Tansley, New Phyt., VI, p. 60, fig. 9.
1909. Scott, Studies, 2d Ed., I, p. 316, fig. 118.
1909. Lotsy, Bot. Stammesgesch., II, figs 393/7, 395/2.

Ankyropteris bibractensis [Williamson (non Renault)] P. Bertrand.

1907. P. Bertrand, C. R. Acad. Sci. Paris, CXLIV, p. 1304.

Rachiopteris irregularis Williamson.

1889. Williamson, On the organization etc., XV, p. 206, fig. 28 (In the explanation of the plates: *Rachiopteris inaequalis)*.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale mijn.
Germany: Rheinpreussen.
Belgium: Bouxharmont.
England: Deighton, Halifax, Huddersfield, Oldham, Shore, Stalybridge.

DUTCH MATERIAL. — Slides 4/5/1-2.

EXTENSIVE DESCRIPTION. — See above: P. BERTRAND 1909.

DESCRIPTION. — Only one small petiole of this species was found (fig. 115). It resembles very closely the petiole figured by BERTRAND (1909), figs 64-65.

XYLEM. — The "apolar", the middle band, which is slightly curved, is in the centre 3-4, at the extre-

mities 2 cells wide, and about 10 cells long. The "antennae", the lateral portions, on the concave side are one cell wide and 7 small, resp. 3 large cells long, those on the convex side one or two cells wide and about 10 cells long. The tracheides of the antennae are smaller than those of the apolar. On the outer side of the antennae lies a band of small xylem elements. The parenchyma which separated this band from the antennae has disappeared, so that an open loop remains in places.

PINNA-TRACES. — No pinna-traces are present.

PHLOEM. — The phloem has entirely disappeared.

CORTEX. — The cortex is wel preserved, the inner consisting of fairly big cells, and the outer of very small cells and sclerenchyma.

EPIDERMIS. — The epidermis is not recognizable.

SPINES. — Externally the petiole is studded with stout spines.

STAUROPTERIS OLDHAMIA Binney.

Stauropteris oldhamia Binney.

1872. Binney, Mem. Proc. Lit. Phil. Soc. Manch., XI, p. 69.
1905. Scott, New Phyt., IV, p. 118, figs 1-2.
1906. Scott, New Phyt., V, p. 170, figs 27-28.
1907. Scott, Progr. Rei Bot., I, p. 185, figs 15-16.
1907. Tansley, New Phyt., VI, p. 64, figs 15-18.
1907. P. Bertrand, C. R. Acad. Sci. Paris, CXLV, p. 147.
1907. P. Bertrand, C. R. Acad. Sci. Paris, CXLV, p. 777.
1908. Bower, Landflora, p. 501, fig. 271.
1909. P. Bertrand, Zygopterid., p. 15, 223, Pl. I, fig. 1; Pl. II, figs 8-13, Pl. III-VII, textfigs 1-8.
1909. Scott, Studies, 2d Ed., I, p. 336, figs 126-128.
1909. Lotsy, Bot. Stammesgesch., II, p. 581, fig. 396.
1910. Seward, Fossil Plants, II, p. 465, figs 308E-G, 310C, 320-321.
1912. P. Bertrand, Progr. Rei Bot., II, p. 226, fig. 17.
1912. Lignier, Bull. Soc. Bot. de France, LXI, 24, p. 8, figs 4, 5, 8.
1914. Pelourde, Paléont. Végét., p. 252, fig. 62, p. 289, fig. 73.
1920. Scott, Studies, 3d Ed., I, p. 329, 413, figs 145-148.
1923. Bower, The Ferns, p. 207, fig. 197.
1925. Leclercq, Mém. in 4° de la Soc. Géol. de Belg., VI, p. 53, Pl. XXXIX, fig. 7, Pl. XL, fig. 8.
1926. Posthumus, Fossilium Catalogus, Plantae, 12, p. 43.
1927. Koopmans, Jaarverslag 1926, p. 50.
1927. Hirmer, Handbuch, I, p. 489. figs 578-585.

Rachiopteris oldhamia (Binney) Williamson.

1874. Williamson, On the organization etc., VI, p. 685, figs 20-27.
1885. Felix, Bericht naturforsch. Ges. Leipzig, p. 10.
1886 Felix, Abh. Geol. Spezialk. Preussen, VII, 3, p. 10, Taf. I, fig. 1.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale mijn.
Germany: Rheinpreussen.
Belgium: Jupille.
England: Dulesgate, Halifax, Oldham, Shore, Stalybridge, Strinesdale.
Hor. – Katharina.
Loc. – Germany: Vollmond.

DUTCH MATERIAL. — Slides 17/1/2, 17/2/1, 28/8/1-2, 91/0/1-2, 139/1/1-3, 139/2/1, 149/0/2-3, 150/0/1-2,

EXTENSIVE DESCRIPTION. — See above: P. BERTRAND 1909, p. 15.

DESCRIPTION. — The specimens consist of fragments of petioles. The outline of every fragment is almost cylindrical.

XYLEM. — The xylem of a primary rachis (figs 116-117) consists of four masses of pitted tracheides, which may be compared to the four arms of *Etapteris* without the connecting middle bar. Each of these arms has a protoxylem group on its lateral angle. BERTRAND (1909) observed that the protoxylem has sunk a little below the surface of the wood. This could not be recognized with certainty in the Dutch slides. In the primary rachis the four xylem-arms are separated by a thin-walled tissue, which, according to BERTRAND, belongs to the phloem. In secondary rachides and those of higher order they have grown together and form one mass of tracheides with four diverging angles.

PHLOEM. — The phloem, which is not usually preserved, fills up the bays between the xylem-arms, so that the outline of the stele is approximately square. About seven large elements can be recognized in the axial plane of symmetry in each bay of the figured specimen (fig. 116), forming a triangle. In the tangential plane no more than three or four are seen, which lie in one row parallel to the xylem-surface. Sieve-plates could not be recognized. According to BERTRAND (1909) the thin-walled tissue just described connecting the arms of the xylem also belongs to the phloem.

PINNA-TRACE. — The pinnae — if it is permissable to use this term, as *Stauropteris* has not got pinnae sensu stricto — branch off in pairs, alternately to the left and to the right. Each strand repeats chiefly the structure of the main bundle. In rachides of tertiary and higher order instead of four only three protoxylem groups may be present.

CORTEX. — The cortex, as far as it is preserved, consists of a fairly uniform sclerosed tissue. The outer layers and the epidermis have been lost.

BOTRYOPTERIS TRIDENTATA (Felix) Posthumus.

Botryopteris tridentata (Felix) Posthumus.

1924. Posthumus, Zittingsverslagen Kon. Akad. Wetensch. Amsterd., XXXIII, p. 883 (Proc., XXVII, p. 836).

1926. Posthumus, Fossilium Catalogus, Plantae, 12, p. 25.

1927. Koopmans, Jaarverslag 1926, p. 50.

1927. Hirmer, Handbuch, I, p. 533. (Fig. 651 is not *B. tridentata*, but *B. forensis* Renault!)

Rachiopteris tridentata Felix.

1885. Felix, Ber. Naturf. Ges. Leipzig, p. 10.

1886. Felix, Abh. Geol. Spez. Karte Preussen, VII, 3, p. 12, Taf. I, fig. 2.

Rachiopteris hirsuta Williamson.

1889. Williamson, On the organization etc., XV, p. 161, figs 9-12.

1894. Williamson, Index, III, p. 70.

Botryopteris hirsuta (Williamson) Scott.

1899. Scott, Rep. Brit. Ass., Bristol, p. 1050.

1900. Scott, Studies, p. 291, fig. 101.

1907. Scott, Progr. Rei Bot., I, p. 179, fig. 12.

1908. Scott, Studies, 2d Ed., I, p. 326, figs 121-122.

1910. Seward, Fossil Plants, II, p. 438.

1910. Pelourde, Ann. Sci. Nat. Bot., (9) XI, p. 378, fig. 8.

1912. P. Bertrand, Progr. Rei Bot., II, p. 240, fig. 322.

1914. Pelourde, Paléontol. Végét., p. 276, fig. 69.

1920. Scott, Studies, 3d. Ed., I, p. 339, figs 149, 151.

1926. Posthumus, Fossilium Catalogus, Plantae, 12, p. 24.

Rachiopteris ramosa Williamson.

1891. Williamson, On the organization etc., XVIII, p. 261, figs 19-28.

1894. Williamson, Index, III, p. 71.

Botryopteris ramosa (Williamson) Scott.

1900. Scott, Studies, p. 291.

1908. Scott, Studies, 2d Ed., I, p. 326.

1910. Seward, Fossil Plants, II, p. 440, fig. 306.

1914. Pelourde, Paléontol, végét., p. 277.

1920. Scott, Studies, 3d Ed., I, p. 339, fig. 150.

1925. Leclercq, Mém. in 4° de la Soc. Géol. de Belg., VI, p. 57, Pl. XLII-XLV, figs 1-7.

1926. Posthumus, Fossilium Catalogus, Plantae, 12, p. 25.

1927. Hirmer, Handbuch, I, p. 533, fig. 650.

DISTRIBUTION. — Everywhere.

DUTCH MATERIAL. — Very common.

EXTENSIVE DESCRIPTION. — A monograph of this genus is much wanted!

DESCRIPTION. — In many sections, petioles of *Botryopteris* are present. Unfortunately not a single stem has been found. Identification with either *Botryopteris ramosa* or *Botryopteris hirsuta* has, therefore, been impossible. I have thought it best to identify them all with the neutral collective species *Botryopteris tridentata* Felix, as a perusal of the literature and of several collections of slides has taught me that as yet it is impossible to distinguish with certainty the petioles of *B. hirsuta* from those of *B. ramosa*. Figures 110-112 show some of the forms which have been found in the Dutch material.

XYLEM. — The xylem consists of an elliptical mass of tracheides, which has generally three, sometimes only one or two, prominent protoxylem-points, directed towards the upper face of the petiole.

PHLOEM. — The phloem is not preserved.

CORTEX. — The cortex consists of a small-celled tissue in which no differentiation could be recognized. On the upper surface it is usually somewhat concave. Hairs or spines have not been observed.

ANACHOROPTERIS WILLIAMSONI Koopmans nom nov.

Rachiopteris gleiche Williamson.

1877. Williamson, On the organization, IX, p. 350, fig. 79.

Rachiopteris rotundata Felix.

1885. Felix, Ber. Naturf. Ges. Leipzig, p. 10.

1886. Felix, Abh. Geol. Spez. Karte Preussen, VII, 3, p. 15, Taf. 3, fig. 2.

Anachoropteris rotundata Scott (non Corda).

1920. Scott, Studies, 3d Ed., I, p. 352, fig. 158.

1927. Koopmans, Jaarverslag 1926, p. 50.

Anachoropteris pulchra Hirmer (non Corda).

1927. Hirmer, Handbuch, I, p. 540, fig. 660.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.

Loc. – Limburg: Domaniale mijn.

Germany: Rheinpreussen.

England: Bacup, Oldham, Shore.

Hor. – Katharina.

Loc. – Germany: Maria, Vollmond.

DUTCH MATERIAL. — Slides 38/1/1-3, 98/6/1, 102/3/2-3, 102/4/1-3, 130/0/1, 148/0/1, 148/2/1.

DESCRIPTION. — Only transverse sections of the petiole are present. Their outline is an ellipse with a slight concavity on the upper side (figs 133-134). Its diameter is usually about 3,5 × 1,5 mm.

XYLEM. — The vascular bundle is extremely incurved, but not spirally involved. The biggest tracheides are on the incurved ends, which are only one or two cells wide. No pits have been observed in the walls. The protoxylem, situated on the left and right upper corners, is badly preserved. The space enclosed by the curvature of the bundle is occupied by a black mass, possibly of sclerenchyma, of equally complex form: a T with rounded edges.

PINNA-TRACES. — No pinna-traces have been observed.

PHLOEM. — The phloem has not been preserved.

CORTEX. — The cortex is of the usual type: an inner cortex of fairly large cells, which diminish gradually towards the outside, and an outer cortex of very small, sclerosed cells.

HAIRS. — No hairs or spines have been seen.

NOMENCLATURE. — CORDA described two species of the genus *Anachoropteris*, *A. pulchra* and *A. rotundata*, both from the Coal-measures of Radnitz (CORDA 1845). An extensive monograph on *A. pulchra* was published by KUBART (1916). Since CORDA'S paper nothing has been published on *A. rotundata*. Figs 135 and 136 are reproductions of the original figures of CORDA. The only drawing of an English specimen of this genus was given by WILLIAMSON (1877), who does not describe it, but only remarks that he can detect no difference between this Oldham specimen and CORDA'S *A.rotundata*. Having read CORDA'S explanation of the plate wrongly, WILLIAMSON calls it *Rachiopteris gleiche* — *Rachiopteris*, because he calls all petioles *Rachiopteris*, and *gleiche*, in stead of *gleichenioides*, the specific name of *Chorionepteris gleichenioides* — imagining that CORDA had named his specimen: *Chorionepteris gleiche*. I have shown several botanists CORDA'S figure, asking them what name belonged to this rachis: it is very curious that all read *Chorionepteris gleiche*, which proves that WILLIAMSON'S error is very easily made. Westfalian specimens were figured by FELIX (1886) and by SCOTT (1920). FELIX gives a short description of his specimen, corrects the error of WILLIAMSON and identifies them as *Rachiopteris rotundata*. SCOTT uses the name *Anachoropteris rotundata (= A. pulchra)* according to BERTRAND (1909) and to KUBART (1916), who think the two species of CORDA identical. In my opinion there is no doubt but the English, Westfalian, and Dutch specimens represent one species. Whether the specimens of CORDA belong to one species or to two, I cannot say, as I have not seen the original slides. But I am convinced that the West-European specimens are not to be identified with either of CORDA'S species. The vascular bundle of *A. pulchra*, as shown in CORDA'S drawing and in KUBART'S beautiful photos, is always spirally involved, that of our specimens is only incurved. Thus it is in *A. rotundata*. But the outline of our specimens is quite different from *A. rotundata*. We need only compare figs 133-134 and 136 to demonstrate the difference more adequately than can be done with words. The outline of all West-European specimens which I have seen is a horizontal ellipse with a concavity on the upper side, that of CORDA'S specimen a vertical oval without any concavity.

I, therefore, propose to recognize the West-European specimens as a separate species and to call it *Anachoropteris Williamsoni* in honour of the first author who has mentioned it.

FERN SPORANGIA.

DUTCH MATERIAL. — Slides 4/2/1, 29/3/1-2, 40/0/1, 40/3/2, 85/0/3, 113/1/2bis, 152/1/1.

DESCRIPTION. — In the above-mentioned slides are found sporangia, most of them empty, which must belong to some member of the *Inversicatenales* (fig. 55). As they are always isolated, specific, and even generic identification is impossible. They are of a roundish shape and the wall consists of one layer of small cells, with on one side a broad band of enlarged cells acting as an annulus.

LYGINOPTERIS OLDHAMIA (Binney) Potonié.

Lyginopteris oldhamia (Binney) Potonié.

1899. Potonié, Pflanzenpalaeont., p. 170.
1900. Zeiller, Paléobot., p. 127, fig. 96.
1917. Seward, Fossil Plants, III, p. 35, figs 402-406.
1923. Scott, Studies, 3d Ed., II, p. 21, figs 11-28.
1924. Scott, Extinct Plants, p. 121, figs 36-37.
1925. Leclercq, Mém. in 4° de la Soc. Géol. de Belg., VI, p. 69, Pl. IX, fig. 13.
1927. Koopmans, Jaarverslag 1926, p. 50.

Dadoxylon oldhamium Binney.

1866. Binney, Mem. Proc. Lit. Phil. Soc. Manch., V, p. 113.

Dictyoxylon oldhamium (Binney) Williamson.

1869. Williamson, Monthly Micr. Journ., II, p. 66.

Lyginodendron oldhamium (Binney) Williamson.

1873. Williamson, On the organization etc., IV, p. 404, figs 1-29, 48.
1887. Solms-Laubach, Einleitung, p. 368, fig. 49.
1890. Williamson, On the organization etc., XVII, p. 89, figs 1-13.
1893. Williamson, Index, III, p. 58.
1896. Williamson and Scott, Further observations, III, p. 705, Pl. XVIII-XXV.
1896. Felix, Földtani Közlöny, XXVI, p. 176.
1900. Scott, Studies, p. 308, figs 102-113.
1902. Arber, E. A. N., Proc. Cambr. Phil. Soc., XI, p. 281, figs 1-2.
1902. Benson, Ann. of Bot., XVI, p. 575, fig. 31.
1902. Lomax, Ann. of Bot., XVI, p. 601.
1907. Scott, Progr. Rei Bot., I, p. 190, figs 18-22.
1907. Scott, Studies, 2d Ed., II, p. 357, figs 129-142.
1909. Lotsy, Bot. Stammesgesch., II, p. 709, figs 500-504.
1910. Coulter and Chamberlain, Gymnosperms, p. 13, figs 11-13.
1913. Weiss, F. E., Mem. Proc. Lit. Phil. Soc. Manch., LVII, 3, p. 1, 1 Pl.
1913. Brenchley, Journ. Linn. Soc., XLI, p. 349.
1921. Potonié-Gothan, Palaeobot., p. 126, figs 112-114.

On the petioles of *Lyginopteris* see also:

Edraxylon Williamson.

1872. Williamson, Proc. Roy. Soc. London, XX, p. 438.

Rachiopteris aspera Williamson.

1874. Williamson, On the organization etc., VI, p. 679, figs 1-14, 16.
1890. Williamson, On the organization etc., XVII, p. 89, figs 1-13.

On the roots of *Lyginopteris* see also:

Kaloxylon Hookeri Williamson.

1876. Williamson, On the organization etc., VII, p. 13, figs 23-38.
1886. Felix, Abh. Geol. Spezialk. Preussen, VII, 3, p. 49, Taf. II, fig. 2.
1887. Williamson, On the organization etc., XIII, p. 294, figs 20-37.
1895. Hick, Mem. Proc. Lit. Phil. Soc. Manch., (4) IX, p. 109, Pl. II.

DISTRIBUTION. — Everywhere.

DUTCH MATERIAL. — Very common. At least 30 specimens.

EXTENSIVE DESCRIPTION. — See above: WILLIAMSON and SCOTT 1896.

DESCRIPTION. — *Lyginopteris oldhamia* is one of the commonest fossils in the Dutch material. Several stems are preserved with great beauty (fig. 120).

MEDULLA. — The medulla consists of a parenchyma, in which sclerotic nests are embedded.

XYLEM. — At the periphery of the pith there are several distinct strands of primary xylem beyond which there is a broad zone of secondary wood, the elements of which are arranged with great regularity in radial rows. This secondary wood is split up by numerous medullary rays, which in tangential section have a muriform outline. The pointed tracheides of both primary and secondary wood are pitted.

PHLOEM. — Though the soft tissues on the outer side of the wood are very well preserved in some of the specimens, no phloem-elements could be recognized as such with certainty. The phloem-rays are clearly shown.

PERICYCLE. — The phloem-zone is surrounded by a ring of thin-walled tissue, which it is best to regard as a pericycle. Embedded in this are groups of sclerotic cells similar to those which are conspicuous in the pith.

PERIDERM. — As a general rule at the exterior of the pericycle there is a layer of periderm consisting of radially arranged elements. This periderm curves outwards opposite the leaf-traces, following their outer surface.

CORTEX. — The inner cortex consists of large-celled collenchyma, among which sac-like cells are scattered in some specimens. It is best preserved in those stems, in which the periderm is not yet present or has been only slightly developed. The thickening at the angles, where the cells meet, is very characteristic. The outer cortex is made up of the well-known alternating, radial bands of sclerotic fibres and parenchyma, forming the Dictyoxylon-cortex. Beyond the sclerotic zone there are a few more layers of parenchyma, more or less imperfectly preserved.

LEAF-TRACE. — With regard to the structure and the course of the leaf-traces I should like to refer to the very extensive description given by SCOTT (Studies, II, 1923, p. 28-33).

ROOTS. — Associated, and even connected, with the stems are found numerous roots of the well-known type of *Kaloxylon Hookeri*.

LEAVES. — Petioles (*Rachiopteris aspera* Will.) and leaves are even more common than the stems themselves.

STRUCTURAL ANOMALIES. — Fig. 120 represents a stem of *Lyginopteris oldhamia*, which shows very clearly the anomaly described by WILLIAMSON and SCOTT (1895, p. 722), the appearance of a secondary meristem, at the outer border of the pith, acting as a regular cambium and producing medullary wood and bast with inverted orientation. The tertiary tracheides are arranged in regular rows and constitute a very conspicuous feature of this slide.

LAGENOSTOMA OVOIDES Williamson.

Lagenostoma ovoides Williamson.

1877. Williamson, On the organization etc., VIII, p. 234, figs 53-75.
1880. Williamson, On the organization etc., X, p. 517, figs 61-63.
1908. Benson, Bot. Gaz., XLV, p. 409, figs 1-2.
1909. Scott, Studies, 2d Ed., II, p. 396.
1910. Coulter and Chamberlain, Gymnosperms, p. 33, figs 28-29, 49.
1912. Prankerd, Linn. Soc. Journ., Bot., XL, p. 461, Pl. XXII-XXIV, 3 textfigs.
1917. Seward, Fossil Plants, III, p. 62, fig. 493A.
1923. Scott, Studies, 3d Ed., II, p. 74.
1924. Scott, Extinct Plants, p. 123, fig. 38.
1927. Koopmans, Jaarverslag 1926, p. 50.

Lagenostoma oviformis Williamson.

1876. Williamson, Rep. 45th meeting (Bristol) Brit. Ass., p. 159.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale mijn.
Germany: Rheinpreussen.
England: Bacup, Deighton, Dulesgate, Halifax, Huddersfield, Oldham, Shore, Stalybridge, Strinesdale.

DUTCH MATERIAL. — Slides 0/0/6, 3/2/1, 22/2/1, 29/3/2, 107/0/1, 108/0/1. 111/0/1, 132/0/4, 132/1/1, 145/2/4, 154/1/1.

EXTENSIVE DESCRIPTION. — See above: PRANKERD 1912.

DESCRIPTION. — Figure 128 shows the best longitudinal section procured of *Lagenostoma ovoides*. The lower part of the sporangium, where it had been inserted, has been lost. No traces of the cupule have been found, either in this or any other slide. The orifice of the sporangium, the pollenchamber with its central column, and the megaspore membrane are very clearly shown. Figure 127 shows a somewhat oblique section through another specimen.

TELANGIUM cf. SCOTTI Benson.

Telangium Scotti Benson.

1904. Benson, Ann. of Bot., XVIII, p. 161, Pl. XI, 1 textfig.
1907. Scott, Progr. Rei Bot., I, p. 201.
1909. Scott, Studies, 2d Ed., II, p. 399.
1909. Lotsy, Bot. Stammesgesch., II, p. 717.
1917. Seward, Fossil Plants, III, p. 54, fig. 493E.
1923. Scott, Studies, 3d Ed., II, p. 78.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale mijn.
England: Oldham, Shore.

DUTCH MATERIAL. — Slides 0/0/3, 40/0/3-4.

EXTENSIVE DESCRIPTION. — See above: BENSON 1904.

DESCRIPTION. — In several slides structures are found probably representing parts of synangia. I am not quite sure that they can be identified with *Telangium Scotti* Benson, but think it best to regard them as belonging to this species until better preserved specimens are found. Figs 123-125 give a good idea of the form and structure of these remains.

PHYSOSTOMA ELEGANS Williamson.

Physostoma elegans Williamson.

1876. Williamson, Rep. 45th meeting (Bristol) Brit. Ass., p. 159.
1909. Oliver, Ann. of Bot., XXIII, p. 73, Pl. V-VII, 10 textfigs.
1909. Scott, Studies, 2d Ed., II, p. 396.
1910. Coulter and Chamberlain, Gymnosperms, p. 34, figs 35-39.
1910. Gordon, Proc. Cambr. Phil. Soc., V, 5, p. 395.
1913. Salisbury, Ann. of Bot., XXVII, p. 273.
1914. Salisbury, Ann. of Bot., XXVIII, p. 74.
1917. Seward, Fossil Plants, III, p. 309, figs 493C-D, 494I.
1923. Scott, Studies, 3d Ed., II, p. 84, fig. 43.
1927. Koopmans, Jaarverslag 1926, p. 50.

Lagenostoma physoides Williamson.

1877. Williamson, On the organization etc., VIII, p. 241, figs 77-79.
1897. Butterworth, Mem. Proc. Lit. Phil. Soc. Manch., XLI, 9, p. 1, 1 Pl.
1903. Oliver, New Phyt., II, p. 18.
1909. Lotsy, Bot. Stammesgesch., II, p. 715.

Sporocarpon ornatum Williamson.

1880. Williamson, On the organization etc., X, p. 510, fig. 39.
1883. Williamson, On the organization etc., XII, p. 469, fig. 27. (In the index to the plates called: *Sporocarpon anomalum.)*

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale mijn.
Germany: Rheinpreussen.
England: Bacup, Dulesgate, Halifax, Oldham, Shore.

DUTCH MATERIAL. —Slide 76/0/3.

EXTENSIVE DESCRIPTION. — See above: OLIVER 1909.

DESCRIPTION. — Though the preservation is bad, the only slide available is striking enough to permit the identification of this seed. It is cut transversely through the pollenchamber (fig. 126) at the same height as textfigure 2C of OLIVER (1909), which is reproduced by SCOTT (1923) in figure 43C. In the centre, a black ellipse represents the apical papilla of the megaspore, which protrudes into the pollenchamber. The pollenchamber-wall is represented by a thin, black line, on the outer side of which are seen the ten tentacles, which are invested by the very conspicuous, long, club-shaped hairs covering the summits of the ridges on the body of the seed and the outside of the tentacles. This investment is a very striking feature of *Physostoma*, making even the smallest fragments easy of identification.

MEDULLOSA ANGLICA Scott.

Medullosa anglica Scott.

1899. Scott, Trans. Roy. Soc. London, B, CXCI, p. 81, Pl. 5-13.
1899. Seward, Proc. Cambr. Phil. Soc., X, 3, p. 168.
1900. Scott, Studies, p. 376, figs 126-130.
1903. Arber, E. A. N., Ann. of Bot., XVII, p. 425, Pl. XX.
1907. Scott, Progr. Rei Bot., I, p. 203, figs 35-37.
1909. Scott, Studies, 2d Ed., II, p. 428, figs 163-167.
1910. Coulter and Chamberlain, Gymnosperms, p. 18, fig. 15.
1909. Lotsy, Bot. Stammesgesch., II, p. 719, fig. 512.
1914. Salisbury, Ann. of Bot., XXVIII, p. 76.
1917. Seward, Fossil Plants, III, p. 90, fig. 416 A-C.
1921. Potonié-Gothan, Palaeobotanik, p. 135.
1923. Scott, Studies, 3d Ed., II, p. 173, figs 70-75C.
1924. Scott, Extinct Plants, p. 127, fig. 39.
1927. Koopmans, Jaarverslag 1926, p. 50.

On the petiole of *Medullosa* see also:

Myelopteris.

1876. Williamson, On the organization etc., VII., p. 1, figs 1-17.

Stenzelia.

1886. Felix, Abh. Geol. Spezialk. Preussen, VII, 3, p. 64, Taf. II, fig. 1.

Myeloxylon.

1893. Seward, Ann. of Bot., VII, p. 1, Pl. I-II.

1910. Holden, New Phyt., IX, p. 253, figs 17-18.

Angiospermophyton americanum Hoskins.

1923. Hoskins, The Bot. Gaz., LXXV, p. 390, Pl. XVII, figs 8-13, textfigs 2-7.

1923. Noë, The Journ. of Geol., XXXI, p. 344, figs 1-2.

1924. Seward, Review, in: The Geol. Mag., LXI, p. 36.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.

Loc. – Limburg: Domaniale mijn.

Germany: Rheinpreussen.

England: Oldham, Shore, Stalybridge.

Hor. – Katharina.

Loc. – Germany: Maria, Vollmond.

DUTCH MATERIAL. — Slides 98/2/1-6, 98/3/1-2, 98/4/1, 98/5/1, 98/6/1, 127/4/4-5.

Myeloxylon: 17/1/1-2, 17/2/1, 91/0/1-2, 102/2/1-3, 102/3/1-2, 149/0/3, 150/0/1-2, 160/7/2-3.

EXTENSIVE DESCRIPTION. — See above: SCOTT 1899.

DESCRIPTION. — Coal-ball 127 contains one small specimen of which only the wood is preserved. Coal-ball 98 contains 4 specimens. One of these is fairly big, but is not quite complete, part of one of the steles being missing (fig. 118). The other three specimens are small (fig. 121). It is not impossible that all four belong to one branching stem, but I have not been able to find conclusive evidence. Only the xylem and the periderm are well preserved, all the soft tissues having been destroyed.

XYLEM. — All transverse sections show three distinctly separate steles. The whole interior of each stele (fig. 119) is occupied by a mass of tracheides forming confluent groups. These groups were probably interspersed with thin-walled conjunctive parenchyma, which is not preserved. A zone of secondary wood of variable thickness surrounds the primary xylem, and is at once distinguished from the primary wood by the radial seriation of its elements. The radial series of tracheides are as a rule more numerous than the medullary rays; usually from two to four series of tracheides intervene between two rays.

PHLOEM and PERICYCLE. — These are not preserved.

PERIDERM. — The development of an internal periderm is a very striking feature in all specimens. It forms a continuous, though very irregular, zone encircling the stem a little within the bases of the leaves. The regular, radial arrangement of the cells at once characterizes this zone as a secondary formation. It usually attains a thickness of 8 to 10 cells (figs 119 and 121).

LEAF-BASES. — The leaf-bases are poorly preserved. As far as can be seen, they have the typical *Myeloxylon* structure. Of the hypoderma only traces are preserved; enough, however, to recognize the *"Sparganum"* cortex. The inner parenchyma is traversed by numerous gum-canals and by collateral vascular bundles. Isolated petioles *(Myeloxylon)* are fairly abundant. Fig. 122 shows a very well preserved specimen.

ROOTS. — Numerous roots have been found associated with the stems. They have the usual triarch structure with well-marked secondary wood and a conspicuous zone of periderm.

MESOXYLON MULTIRAME Scott and Maslen.

Mesoxylon multirame Scott and Maslen.

1910. Scott and Maslen, Ann. of Bot., XXIV, p. 238.

1918. Scott, Ann. of Bot., XXXII, p. 437, Pl. XI-XIV, 2 textfigs.

1921, Potonié-Gothan, Palaeobotanik, p. 254.

1923. Scott, Studies, 3d Ed., II,, p. 278, figs 103, 112.

Mesoxylon sp.

1927. K o o p m a n s, *Jaarverslag 1926, p. 50.*

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.

Loc. – Limburg: Domaniale mijn.

England: Shore.

DUTCH MATERIAL. — Slides 128/0/1-5, 158/0/1-2, 161/0/1-6, 161/1/1-11.

EXTENSIVE DESCRIPTION. — See above: SCOTT 1918.

DESCRIPTION. — Coal-ball 128 contains only the xylem of a *Mesoxylon;* coal-ball 158 contains a complete specimen, which, however, is very poorly preserved. Nevertheless I think that both must be ascribed to *Mesoxylon multirame*. My description will be based on the specimen from coal-ball 161, which is better preserved and is fairly complete.

MEDULLA. — The pith, which is badly preserved, seems to be of the ordinary discoid type. Figs 130 and 129 represent respectively a section through one of these discs and a section between two of them. The diameter of the medulla is about 15 × 20 mm.

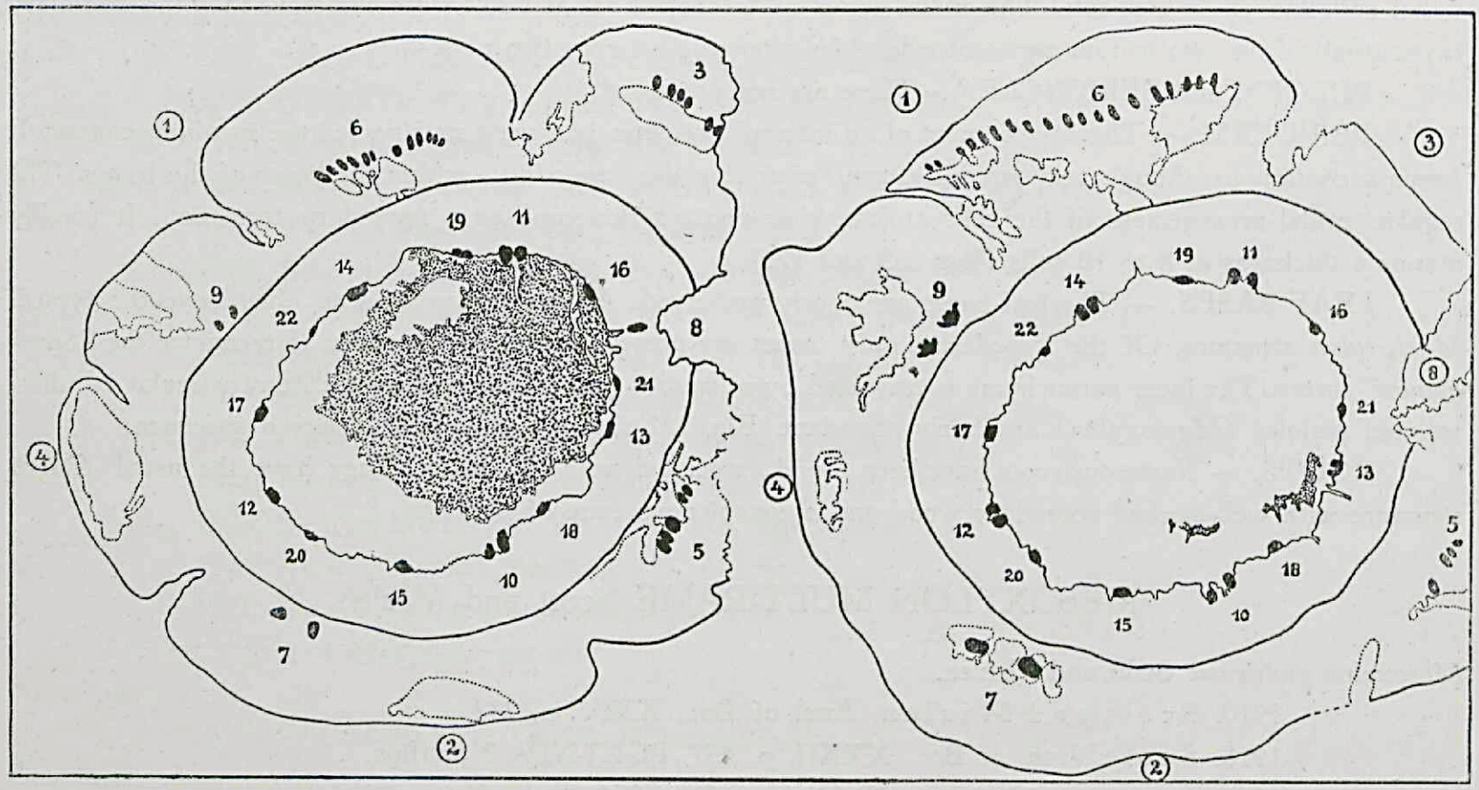
XYLEM. — The primary wood cannot be recognized, but the secondary wood, about 3 mm thick, is well preserved. The tracheides are arranged in radial rows of about 100 cells. No pits can be observed. The medullary rays are uniseriate, 1-12 cells in height. No wood-parenchyma is present.

PHLOEM. — The phloem is about 0,6 mm thick. It consists of some 15 rows of cells, which are distinctly different in size. Whether the three kinds of cells described by SCOTT (1918, p. 450) are present cannot be decided with certainty.

PERICYCLE. — The pericycle (average width about 1 m.m.) is to be recognized at once from the phloem by the irregular arrangement and the greater size of the cells. The matrix is formed of small-celled parenchyma, but embedded in this are very numerous and peculiar sacs, of large size, sometimes filled with black material.

PERIDERM. — The periderm, formed at the outside of the pericycle, consists of 5-15 small, tangentially elongated cells.

CORTEX. — The cortex is a broad zone of an irregular parenchyma. The inner part contains a few



Textfig. 3: Two consecutive sections of Mesoxylon multirame, showing 22 leaf-traces. The numerals enclosed in a circle represent leaf-traces, whose place could be ascertained in lower sections of the same stem.

sac-like cells resembling those of the pericycle. On the outer side the greater part of this zone is occupied by a mechanical *Dictyoxylon* tissue. The fibrous bands of this *Dictyoxylon* cortex often form a network.

LEAF-TRACE. — The structure and behaviour of the leaf-traces closely agree with the detailed description given by SCOTT (1918, p. 439 and 446). After reaching the pith the twin bundles of the trace remain distinct for several internodes and never definitely fuse before they are merged into the woody zone. The trace divides into eight bundles in the cortex. The centropetal xylem persists about as long as the two strands remain distinct (figs 131-132). Textfigure 3 shows diagrammatically the relative position of 18 leaf-traces in slides 161/0/5-6. The phyllotaxis is of the main series.

LEAVES. — Both in coal-ball 158 and 161 leaves are found associated with the stems. They are of the usual Cordaitean type (See: *Cordaites Felicis*, figs 62-65).

CORDAITES FELICIS Benson.

Cordaites Felicis Benson.

1912. Benson, Ann. of Bot., XXVI, p. 201, Pl. XXII, 1 textfig.
1917. Seward, Fossil Plants, III, p. 227, fig. 465.
1927. Koopmans, Jaarverslag 1926, p. 50.
1927. Leclercq, Ann. Soc. Géol. de Belg., LI, 2, p. 56, fig. 1.

Mesoxylon Felicis (Benson) Scott.

1923. Scott, Studies, 3d Ed., II, p. 292.

Cordaites loculosus Felix.

1886. Felix, Abh. Geol. Spez. Karte Preussen, VII, 3, p. 63, Taf. III, fig. 5.
1912. Benson, Ann. of Bot., XXVI, p. 205.

Cordaites robustus Felix.

1886. Felix, Abh. Geol. Spez. Karte Preussen, VII, 3, p. 64, Taf. III, fig. 1.
1912. Benson, Ann. of Bot., XXVI, p. 205.
1917. Seward, Fossil Plants, III, p. 227.

Cordaites Wedekindi Felix.

1886. Felix, Abh. Geol. Spez. Karte Preussen, VII, 3, p. 61, Taf. III, fig. 4.
1912. Benson, Ann. of Bot., XXVI, p. 205.
1923. Scott, Studies, 3d Ed., II, p. 292.

Cordaites weristeri Leclercq.

1927. Leclercq, Ann. Soc. Géol. de Belg., LI, 2, p. 57, figs 1-2, 2-6bis.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale mijn.
Germany: Rheinpreussen.
Belgium: Bouxharmont.
England: Dulesgate, Halifax, Shore.
Hor. – Katharina.
Loc. – Germany: Maria, Vollmond.

DUTCH MATERIAL. — Slides 92/0/1-2, 158/0/1-2, 161/0/1-4.

EXTENSIVE DESCRIPTION. — See above: FELIX 1886, BENSON 1912, LECLERCQ 1927.

DESCRIPTION. — All the specimens of Cordaitean leaves in the Dutch material are poorly preserved. They are of the general Cordaitean structure, with numerous parallel collateral bundles. Three types can be distinguished:

a: Complete fibrous partitions, longitudinally disposed, alternating with the bundles. Each bundle is surrounded by a well-developed sheath *(Cordaites Wedekindi* Felix) (fig. 64).

b: Complete fibrous partitions. No sheath. *(Cordaites loculosus* Felix) fig. 62-63).

c: No fibrous partitions. Sheath present. *(Cordaites weristeri* Leclercq) (fig. 65).

DR. BENSON (1912) has been able to show that the species of FELIX are probably part of the same leaf. Although she has not definitely identified them with *Cordaites Felicis* Benson, the evidence points to their identity with this species.

DR. SUSANNE LECLERCQ (1927) has recently given a description of some leaves, which she calls *Cordaites weristeri* and which are probably identical with my third type. While it is possible that *Cordaites weristeri* represents a distinct species, it is a very curious fact, that MISS LECLERCQ finds in the same slide a leaf of *Cordaites Felicis,* Cordaitean leaves being vere rare in the Belgian material, and it is a still more curious coincidence that FELIX, MISS BENSON, and myself, also find several forms together in the same ball. FELIX finds associated *C. Wedekindi* and *C. loculosus,* MISS BENSON forms resembling *C. Wedekindi, C. loculosus,* and *C. robustus,* and I have forms resembling *C. Wedekindi* and *C. weristeri,* even in two coal-balls (158 and 161). As Cordaitean leaves are always rather rare, it seems highly improbable that in all these cases more than one species is present, the more so, as MISS BENSON has shown her specimens to belong to one species. Under the circumstances I am inclined to regard *Cordaites weristeri* Leclercq as a synonym of *Cordaites Felicis* Benson and identify all my specimens with *Cordaites Felicis* Benson.

AFFINITIES. — In coal-ball 158 and 161 these leaves are closely associated with *Mesoxylon multiramc* Scott and Maslen. Though as yet they have not been found in connection with this stem, it seems fairly certain that they represent its foliage. In the absence of clear proof that they cannot belong to any other genus, e.g. *Cordaites,* I do not think it advisable to call them *Mesoxylon Felicis,* as proposed by SCOTT (1923).

AMYELON RADICANS Williamson.

Amyelon radicans Williamson.

1872. Williamson, Proc. Roy. Soc. London, XX, p. 436.
1874, Williamson, On the organization etc., V, p. 67, figs 46-56.
1886. Felix, Abh. Geol. Spez. Karte Preussen, VII, 3, p. 52, Taf. III, fig. 3.
1887. Solms-Laubach, Palaeophytologie, p. 378.
1909. Scott, Studies, 2d Ed., II, p. 530, fig. 191.
1909. Osborne, Ann. of Bot., XXIII, p. 603.
1910, Coulter and Chamberlain, Gymnosperms, p. 171, fig. 203.
1923. Scott, Studies, 3d Ed., II, p. 286, fig. 105.
1927. Koopmans, Jaarverslag 1926, p. 50.
1927, Leclercq, Ann. Soc. Géol. de Belg., LI, 2, p. 63, figs 7-8.

Dictyoxylon radicans Williamson.

1872. Williamson, Rep. Brit. Ass., 41st meeting (Edinb.), p. 111.

DISTRIBUTION. — *Hor.* – Finefrau-Nebenbank.
Loc. – Limburg: Domaniale mijn.
Germany: Rheinpreussen.
Belgium: Bouxharmont.
England: Dulesgate, Halifax, Oldham, Shore, Strinesdale.
Hor. – Katharina.
Loc. – Germany: Maria, Vollmond.

DUTCH MATERIAL. — Slides from coal-balls 4, 13, 25, 26, 38, 81, 85, 92, 95, 98, 110, 112, 126, 143, 158.

DESCRIPTION. — Though it is generally accepted that *Amyelon* represents the root of *Mesoxylon*

and *Cordaites*, I prefer to consider it as a distinct species, as it is not yet possible to identify it with the stem to which it belongs. In the Dutch specimens only the xylem and the periderm are preserved.

XYLEM. — In the figured specimen (fig. 61) the centripetal primary wood is pentarch. Owing to contraction it is very clearly shown in this slide, but in the other specimens it is very difficult to distinguish the primary from the secondary wood. The primary wood is usually triarch. The secondary zone is made up of radially arranged tracheides. In some longitudinal sections *Araucarioxylon*-pits can be recognized.

PERIDERM. — The periderm consists of several layers of radially arranged elements.

EXPLANATION OF PLATES.

All figured slides and slabs are in the collection of the „Geologisch Bureau voor het Nederlandsche Mijngebied" at Heerlen.

Figures 1-12: *Lepidophloios laricinus* Sternberg.

Fig. 1. Slide 144/9/2. × 5. Transverse section showing the xylem, the outer cortex, and the leaf-bases. In several leaf-bases the ligular pit, the vascular bundle, and the parichnos are clearly shown.

Fig. 2. Slide 144/13/2. × 5. Radial section through the leaf-bases. In the upper one the ligula is seen inside the ligular pit and to the left of this the parichnos.

Fig. 3. Slide 144/13/6. × 5. Tangential section through the leaf-bases. This section has been cut so near to the cortex that in several leaf-bases the ligular pit is not yet present and the parichnos has not yet branched into two.

Fig. 4. Slide 144/9/10. × 5. Tangential section through the outer part of the leaf-bases.

Fig. 5. Slide 144/9/1. × 10. Transverse section through the xylem.

Fig. 6. Part of the same × 25, showing the corona and the outgoing leaf-traces.

Fig. 7. Slide 144/0/3. × 2. Transverse section through another specimen.

Fig. 8. Slide 144/8/2. × 2. Tangential section through the leaf-bases.

Fig. 9. Slide 144/8/4. × 2. Tangential section through the cortex.

Fig. 10. Slide 144/8/6. × 2. Radial section through the xylem and the leaf-bases.

Fig. 11. Slide 144/8/10. × 50. Tangential section through the xylem, showing the bifurcating of the protoxylem-ridges. Compare textfigure 2.

Fig. 12. About natural size. Block 1578 from the Wild collection at Manchester, showing the outer surface of *Lepidophloios laricinus*.

Figures 13-26: *Lepidophloios macrolepidotus* Goldenberg.

Figs 13-22. Polished slabs from coal-ball 162. × 2. Heerlen coll. 753/A 1-2, 753/B 6, 15, 753/D 1-4.

Figs 13-15. Transverse sections of the leaf-bases at different levels.

Figs 16-20. Five consecutive tangential sections of the same leaf-bases from without inwards.

Fig. 21. Radial section through a leaf-base showing the course of the ligular pit.

Fig. 22. Radial section through a leaf-base showing the course of the parichnos.

Figs 23-26. Slides 8/1/5, 8/1/4. 8/1/3, 8/1/2 × 2. Four consecutive tangential sections of another specimen, showing the same leaf-bases at different levels, from within outwards.

Figures 27-32: *Lepidodendron Hickii* Watson.

Fig. 27. Slide 160/10/8. × 3. Transverse section through a very complete stem of moderate age.

Fig. 28. The xylem of fig. 27, magnified 25 times.

Fig. 29. Slide 160/7/1. × 3. Somewhat oblique section through the same stem. Compare WILLIAMSON, On the organization, XI, fig. 9!

Fig. 30. Slide 13/3/4. × 3. Tangential section at the periphery of the leaf-bases. Observe the aerenchyma.

Fig. 31. Slide 160/10/7. × 3. Tangential section through the leaf-bases at a deeper level.

Fig. 32. Slide 160/10/5. × 3. Radial section through the leaf-bases, showing the course of the ligular pit.

Fig. 33. *Sigillaria cf. elegans* Brongniart. Slide 64/0/1. × 25. Transverse section through the xylem.

Figures 34-50: *Lepidodendron obovatum* Sternberg. All figures from polished slabs from coal-ball 167 and magnified 2 times, except figure 48, which is about natural size. Heerlen coll.: 755/A 1-13, 755/B 1, 755/D 1, 3.

Figs 34-36. Thirteen consecutive transverse sections from below upwards through the same leaf-bases, showing its outer surface and the position of the ligular pit, the vascular bundle, and the parichnos at different levels. Observe the aerenchyma in figs 37-38.

Fig. 47. Radial section through two leaf-bases.

Fig. 48. Outer surface of the block.

Figs 49-50. Tangential sections of the same leaf-bases at different levels.

Figures 51-54, 56-60: *Lepidodendron aculeatum* Sternberg. All figures from polished slabs from coal-ball 166 and magnified 2 times. Heerlen coll.: 754/B 1-5, 754/C 4, 754/E 2, 5, 754/F 1.

Fig. 51. Radial section through a leaf-base, showing the parichnos and the ligular pit.

Figs 52-54. Tangential sections through the leaf-bases, showing their structure at different levels. Observe the aerenchyma in fig. 52.

Figs 56-60. Five consecutive transverse sections of the same leaf-bases from below upwards.

Fig. 55. Slide 152/1/1. × 30. Sporangia of some member of the *Primofilices*.

Fig. 61. *Amyelon radicans* Will. Slide 13/2/2. × 10. Transverse section through a root of moderate age.

Figures 62-65: *Cordaites Felicis* Benson.

Fig. 62. Slide 92/0/2. × 10 (*C. loculosus* Felix).

Fig. 63. Part of the same × 30.

Fig. 64. Slide 158/0/2. × 25 (*C. Wedekindi* Felix).

Fig. 65. Slide 158/0/2. × 25 (*C weristeri* Leclercq).

Figures 66-70: *Lepidostrobus oldhamius* Will.

Fig. 66. Slide 28/1/3. × 7/3. Transverse section through a strobilus.

Fig. 67. Slide 28/2/3. × 7/3. Radial section through the same specimen.

Fig. 68. Slide 131/0/3. × 3. Transverse section through a crushed specimen.

Fig. 69. Slide 40/4/1. × 25. Transverse section through an isolated axis showing beautifully the arrangement of the sporophyll-traces.

Fig. 70. Slide 145/2/2. × 5. Transverse section through the top of a young strobilus, showing the sterile tissue in the sporangia.

Fig. 71. *Lepidostrobus cf. foliaceus* Maslen. Slide 40/6/2. × 5. Nearly radial section.

Fig. 72. *Stigmaria arachnoidea* nov. spec. Slide 56/0/2. × 10. Two appendages. Compare fig. 92.

Figures 73-75: *Lepidostrobus Binneyanus* A. Arber.

Fig. 73. Slide 40/2/6. × 10. Obliquely radial section. Note the downward curve of the vascular bundle of the uppermost sporophyll.

Fig. 74. Slide 40/2/5. × 10. Tangential section. Observe the development of the wings of the sporophyll.

Fig. 75. Slide 40/3/2. × 10. Transverse section. Note that the xylem is nearly solid.

Figures 76-80: *Lepidocarpon Lomaxi* Scott.
Fig. 76. Slide 96/1/2. × 10. Tangential section through a cluster of "seeds" in the mature condition.
Fig. 77. Slide 5/3/2. × 10. Tangential section through a seed in the naked condition.
Fig. 78. Slide 28/9/2. × 10. Tangential section through a small, mature, seed. Observe the very long "micropyle".
Fig. 79. Slide 63/0/2. × 5. Horizontal section through a mature seed.
Fig. 80. Slide 96/5/2. × 5. Tangential section through a mature seed.

Figures 81-84: *Stigmaria ficoides* Sternberg.
Fig. 81. Slide 12/2/2. × 40/3. Transverse section of the cortex.
Fig. 82. Slide 12/2/2. × 40/3. Transverse section of the xylem.
Fig. 83. Slide 12/3/2. × 40/3. Tangential section of the xylem. Observe the regular arrangement of the appendage-traces.
Fig. 84. Slide 54/0/3. × 20/3. Transverse section of xylem, cortex, and appendages of another specimen.

Figures 85-86: *Diploxylon 144.*
Fig. 85. Slide 144/10/2. × 2. Transverse section of xylem and cortex. Observe the lamellae of the periderm.
Fig. 86. Slide 144/11/3. × 10. Transverse section of the xylem.

Figures 87-88. *Diploxylon 89.* Slide 89/0/5. × 10. Transverse section of the xylem.

Fig. 89. *Lepidodendron obovatum* Sternberg. Slide 167/0/1. × 10. Transverse section of the xylem.

Figures 90-91 bis: *Lepidophloios macrolepidotus* Goldenberg.
Fig. 90. Slide 162/1/2. × 10. Transverse section of the xylem.
Fig. 91. Outer surface of a block from the English Coal-measures in the Heerlen collection. (no. 225). The structure of the stem contained in this block is the same as that of my specimens.
Fig. 91 bis. Slide in the Heerlen collection (no. 225/1) cut from the block of fig. 91, × 25. Transverse section of the xylem, showing the corona.

Fig. 92. *Stigmaria arachnoidea* nov. spec. Slide 56/0/2. × 25. Compare fig. 72.
Fig. 93. *Stigmaria cf. bacupensis* Scott. Slide 60/0/3. × 10.
Fig. 94. *Sigillariopsis laevis* nov. spec. Slide 27/0/3. × 10.
Fig. 95. *Mazocarpon cf. shorense* Benson. Slide 27/0/2. × 10.
Fig. 96. *Sigillaria cf. mamillaris* Brongniart. Block 715 of the Heerlen collection. About natural size.
Fig. 97. *Sphenophyllostachys Dawsoni* (Will.) Seward. Slide 27/6/3. × 10. Obliquely radial section.
Fig. 98. *Sphenophyllum perforatum* nov. spec. Slide 145/0/1. × 25.
Fig. 99. *Sphenophyllum minus* nov. spec. Slide 40/0/8. × 25.
Figures 100-104. *Sphenophyllum plurifoliatum* Will. et Scott. Slides 27/0/9-27/0/5. × 25.
Fig. 105. *Calamites communis* Binney. Slide 28/3/4. × 5. Transverse section through a stem of moderate age.
Fig. 106. *Calamostachys oldhamia* Hick and Lomax. Slide 89/0/6. × 5. Radial section.
Fig. 107. *Calamostachys Binneyana* (Carr.) Schimp. Slide 28/7/2. × 10. Tangential section.

Figures 108-109: *Palaeostachya vera* Seward.
Fig. 108. Slide 60/0/3. × 10. Oblique section. Above the axis three, and to the right of it two, sporangiophores are seen as black dots in the structureless mass of spores.
Fig. 109. Slide 98/5/1. × 10. Oblique section through the axis. Note the sixteen protoxylem-canals.

Figures 110-112: *Botryopteris tridentata* (Felix) Posthumus.
Fig. 110. Slide 28/8/3. × 40/3.

Fig. 111. Slide 127/4/2. × 10.

Fig. 112. Slide 28/9/2. × 10. Branching petiole.

Figures 113-114: *Etapteris Scotti* P. Bertrand.

Fig. 113. Slide 28/8/4. × 10. Observe the outgoing leaflet-traces in the cortex and the much smaller aphlebia-traces.

Fig. 114. Slide 5/3/2. × 10.

Fig. 115. *Ankyropteris westphaliensis* P. Bertrand. Slide 4/5/1. × 10. Note the spines on the cortex. To the left: Megaspore of *Lepidodendron* or *Bothrodendron*.

Figures 116-117: *Stauropteris oldhamia* Binney.

Fig. 116. Slide 139/1/1. × 25.

Fig. 117. Slide 28/8/2. × 33.

Figures 118-119, 121: *Medullosa anglica* Scott.

Fig. 118. Slide 98/6/1. × 3. Transverse section through a nearly complete stem. The leaf-bases to the right are not preserved.

Fig. 119. Slide 98/2/3. × 10. One of the steles of another slide of the same specimen. To the right a leaf-trace is passing out.

Fig. 121. Slide 98/6/1. × 5. A small stem in which the three steles and the periderm are clearly shown.

Fig. 120. *Lyginopteris oldhamia* (Binney) Potonié. Slide 14/1/4. × 10. Above a root is seen passing out. Between the xylem and the cortex several leaf-traces are seen. Observe the centripetal, secondary wood in the medulla.

Fig. 122. *Myeloxylon*. Slide 150/0/2. × 7.

Figures 123-125: *Telangium cf. Scotti* Benson.

Fig. 123. Slide 102/3/2. × 10. Two empty synangia and a petiole of *Etapteris cf. Scotti*.

Fig. 124. Slide 0/0/3. × 10.

Fig. 125. Slide 40/0/3. × 10.

Fig. 126. *Physostoma elegans* Will. Slide 76/0/3. × 10 Transverse section through the top of a seed.

Figures 127-128: *Lagenostoma ovoides* Will.

Fig. 127. Slide 3/2/1. × 10. A somewhat oblique section.

Fig. 128. Slide 132/1/1. × 10. Nearly radial section.

Figures 129-132: *Mesoxylon multirame* Scott and Maslen.

Fig. 129. Slide 161/0/6. × 3. Transverse section through the stem between two of the diaphragms.

Fig. 130. Slide 161/0/5. × 3. Transverse section immediately below that of fig. 129, through a diaphragm of the medulla. Compare the development of the leaf-traces in both slides. Compare also textfigure 3 which shows the same slides.

Figs 131-132. Slide 161/0/6. Leaf-traces at the periphery of the medulla showing the centripetal, primary wood.

Figures 133-134: *Anachoropteris Williamsoni* nom. nov.

Fig. 133. Slide 98/6/1. × 25.

Fig. 134. Slide 148/2/1. × 25.

Fig. 135. *Anachoropteris pulchra* corda. × ?. (After Corda, reduced.)

Fig. 136. *Anachoropteris rotundata* Corda. × ?. (After Corda, reduced.)

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STELLINGEN.

I

Tusschen de Isoetineae en de Lycopodineae bestaan slechts habitueele overeenkomsten.

II

Lepidodendron en zijn verwanten behooren tot de Isoetineae.

III

Het voorkomen van eenzelfde fossiele flora in gebieden met verschillende breedtegraad bewijst niet, dat de daarbij behoorende afzettingen synchronisch zijn.

IV

Voor het bestaan hebben van een tropische of subtropische altijd-groene loofboom-flora in de poolstreken is het noodzakelijk aan te nemen, dat de relatieve ligging van deze gebieden ten opzichte van de polen van de huidige verschillend moet zijn geweest.

V

De sphenothorax-theorie van Feuerborn inzake de segmentatie van de insecten-thorax is absoluut onhoudbaar.

VI

De bezwaren, door Fraülein von Ubisch tegen de statolithen-theorie ingebracht, zijn niet afdoende (Biol. Zentralbl., 1928, p. 172).

VII

Het is ongewenscht botanische excursies van groepen studeerenden of liefhebbers te brengen naar vindplaatsen van zeldzame planten.

VIII

De beste vooropleiding voor alle faculteiten is de natuurwetenschappelijke afdeeling van de Hoogere Burgerschool, gevolgd door een aanvullingsexamen in Latijn en Grieksch.

IX

Het is niet wenschelijk, dat proefschriften ter verkrijging van den graad van Doctor in de exacte wetenschappen aan een Nederlandsche Universiteit in het Nederlandsch geschreven zijn, tenzij zij voorzien zijn van een zeer uitgebreid résumé in een der meest verspreide Europeesche talen.

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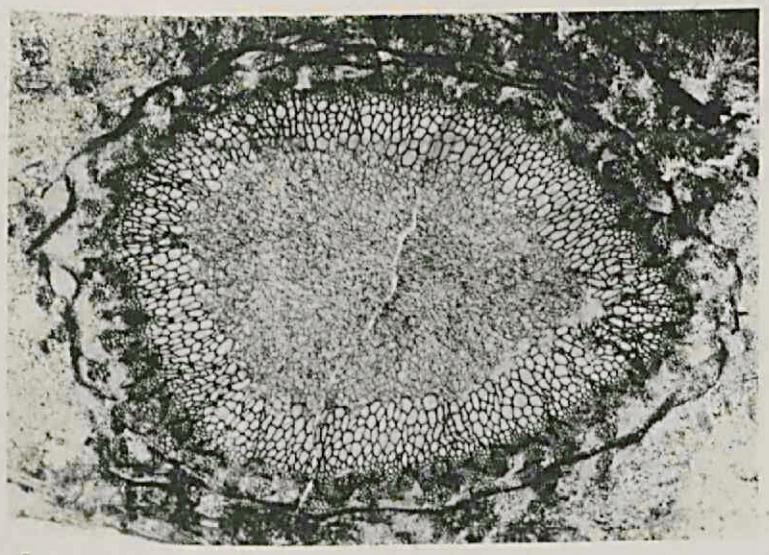

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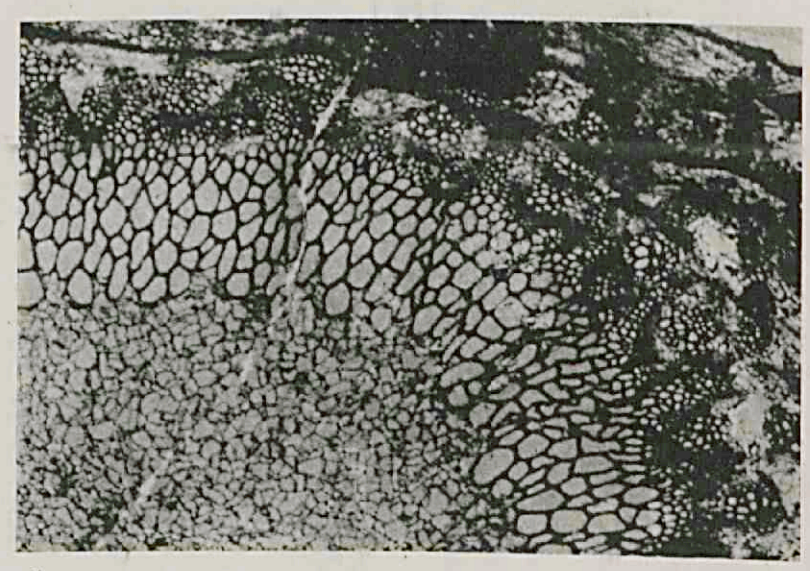

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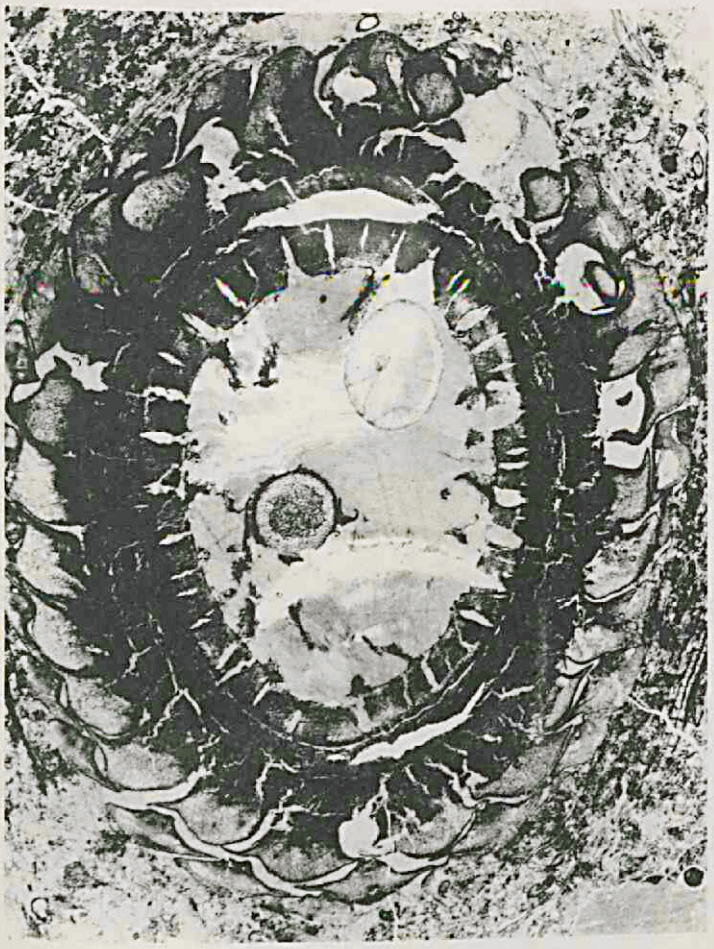
1-6 : *Lepidophloios laricinus*



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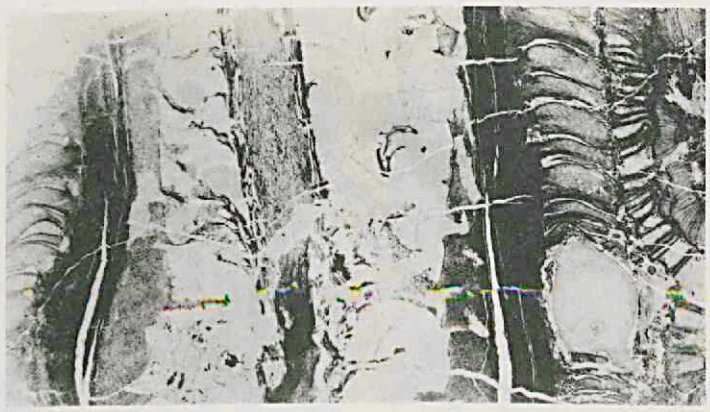

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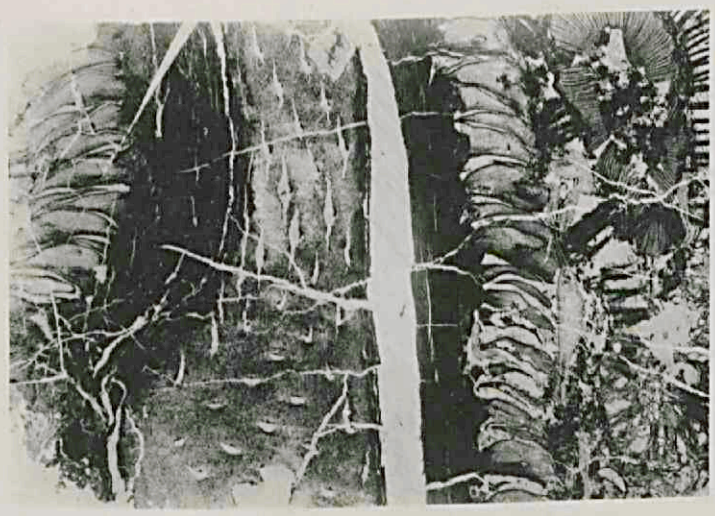

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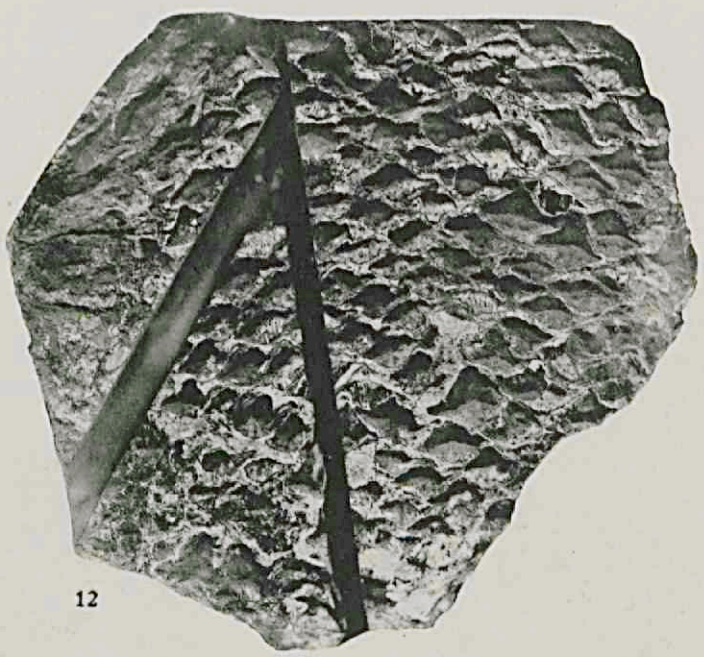

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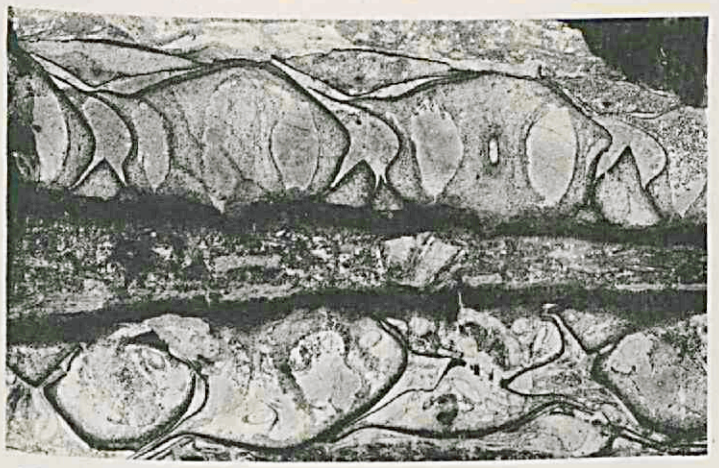
7-12 : *Lepidophloios laricinus*



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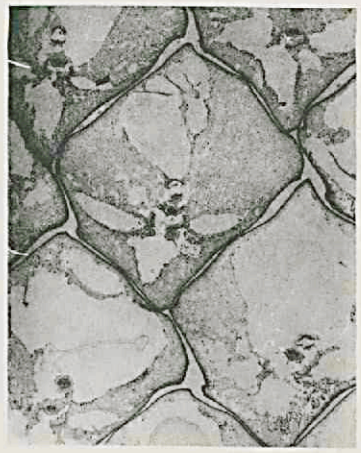

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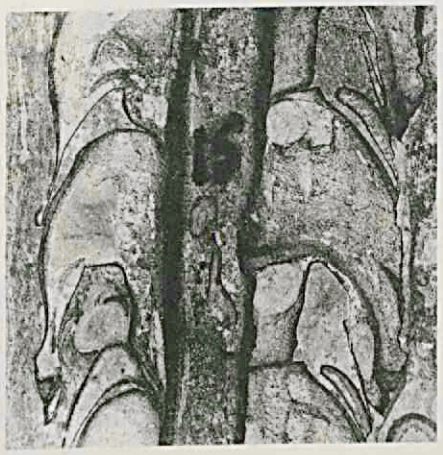

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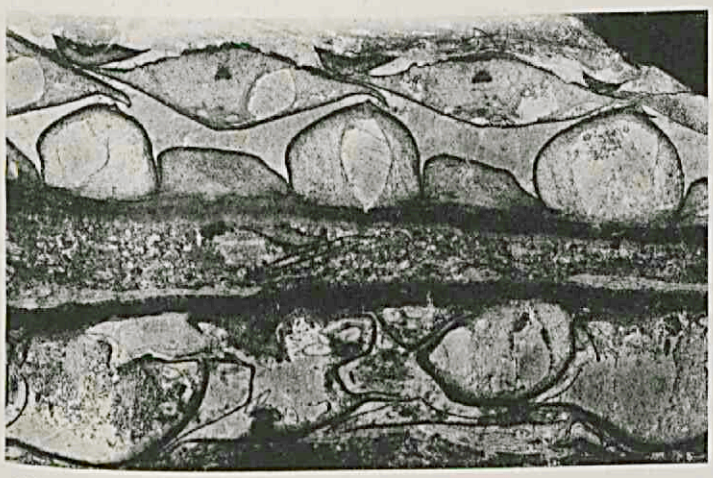

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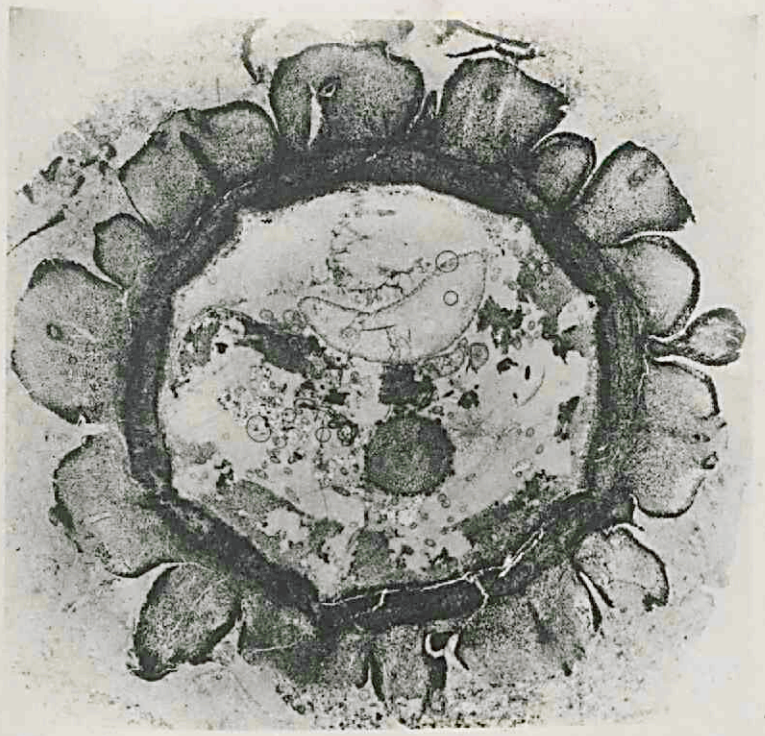
13-26 : *Lepidophloios macrolepidotus*



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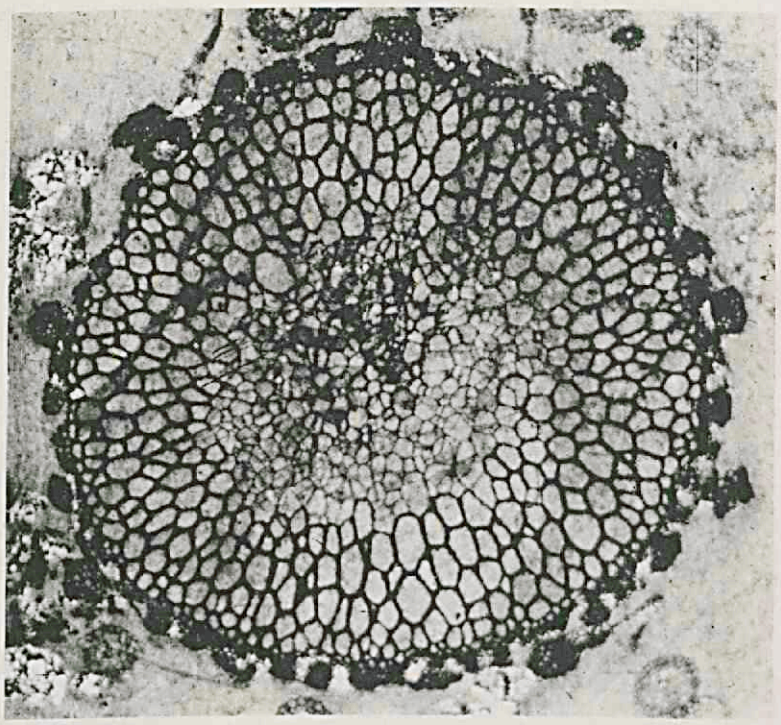

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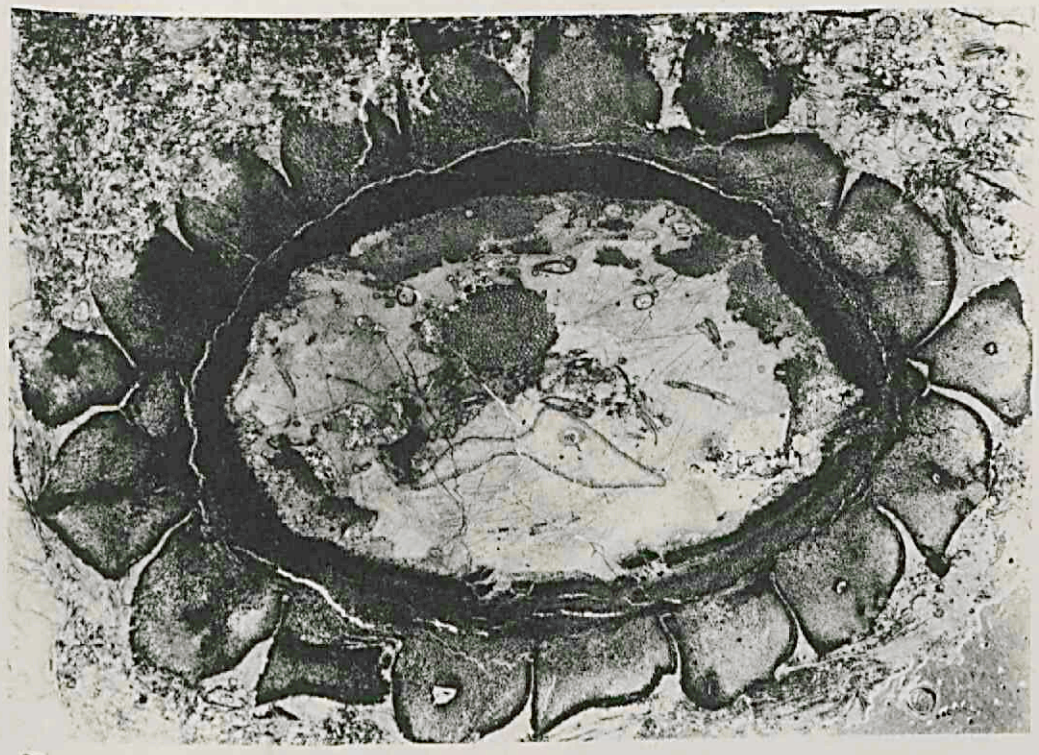

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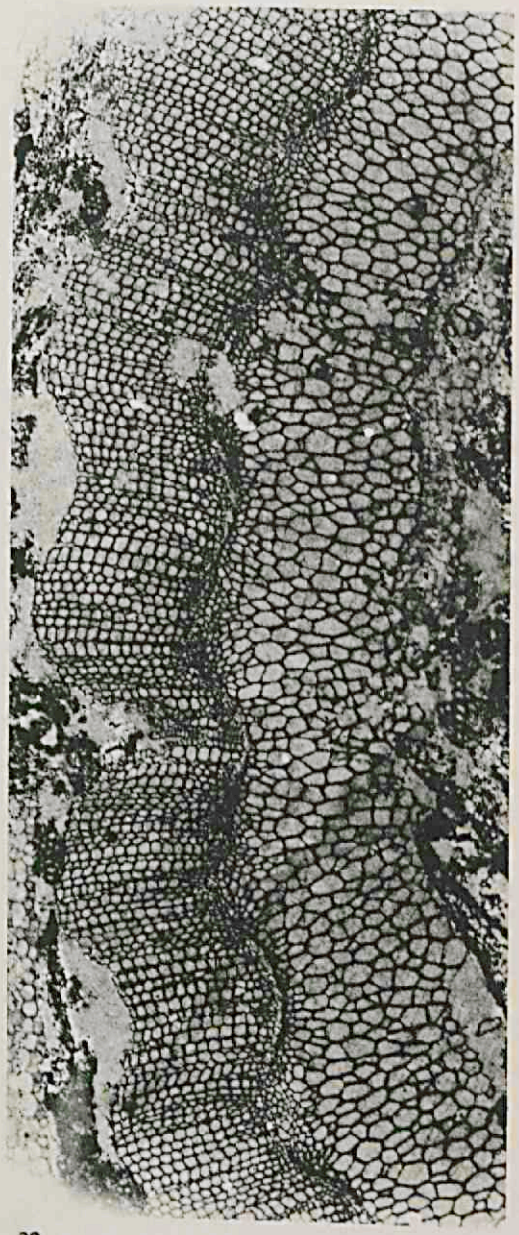

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27-32 : Lepidodendron Hickii — 33 : Sigillaria cf. *elegans*

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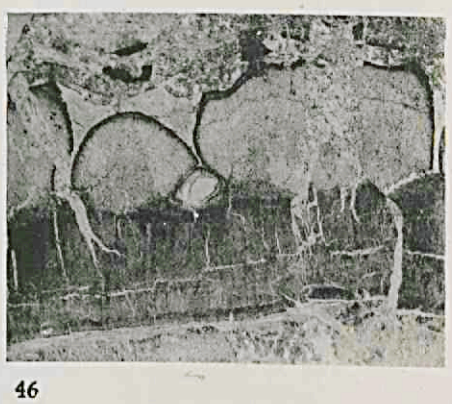

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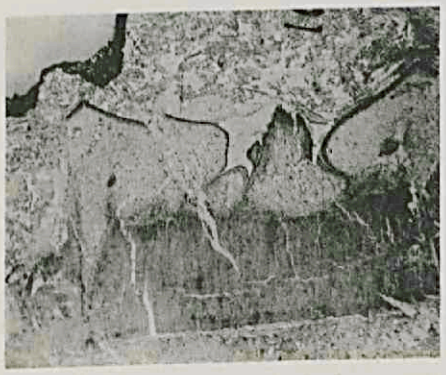

43

34-47 : *Lepidodendron obovatum*

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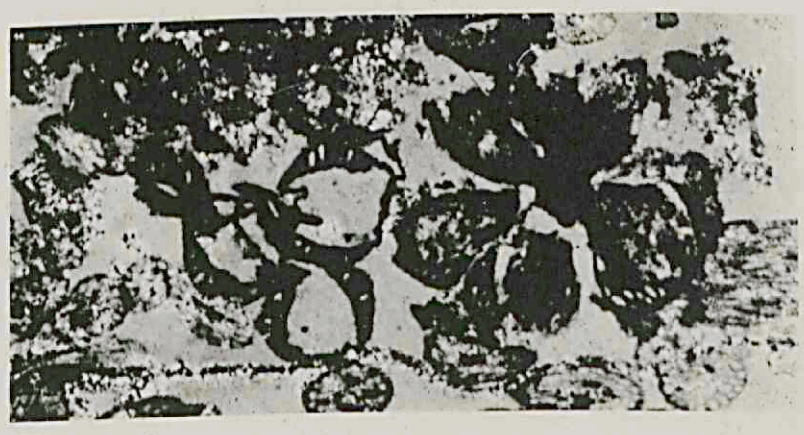

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48-50 : *Lepidodendron obovatum* — 51-54 : *Lepidodendron aculeatum* — 55 : *Sporangia* cf. *Botryopteris*

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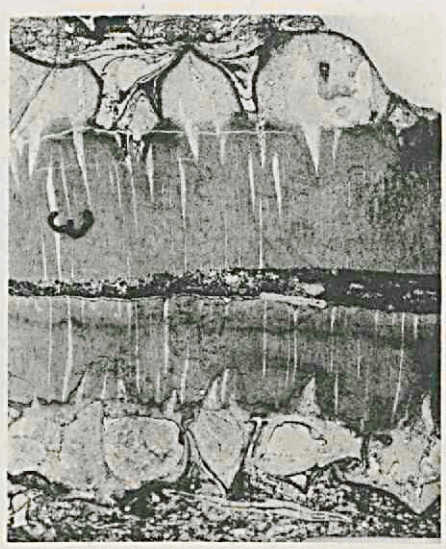

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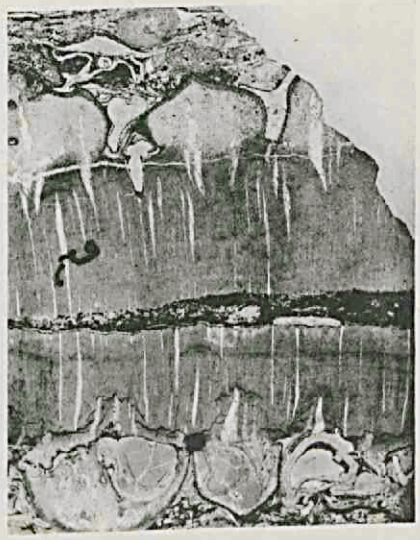

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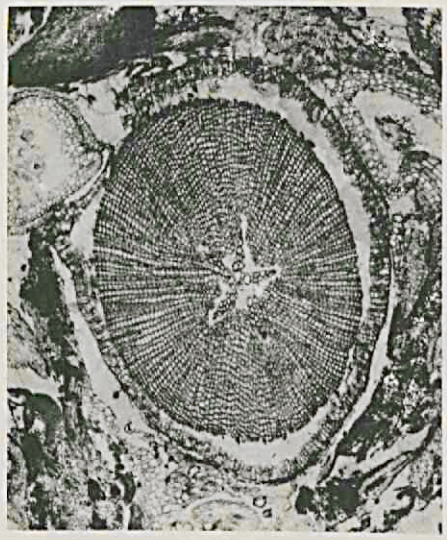

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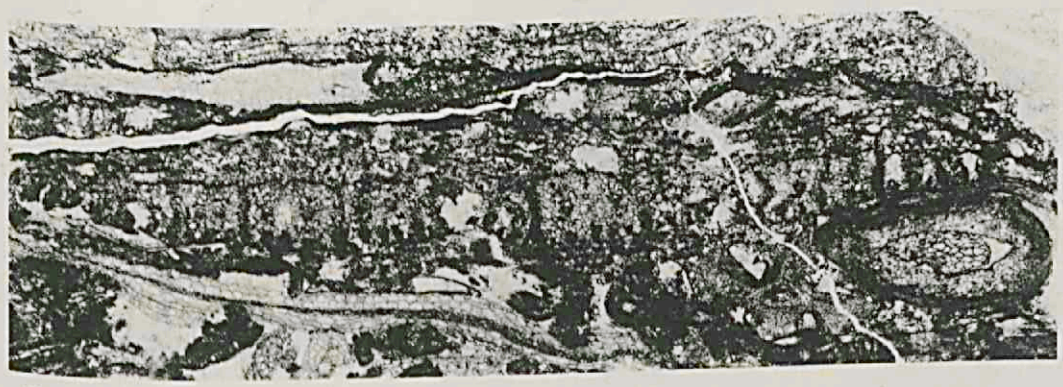

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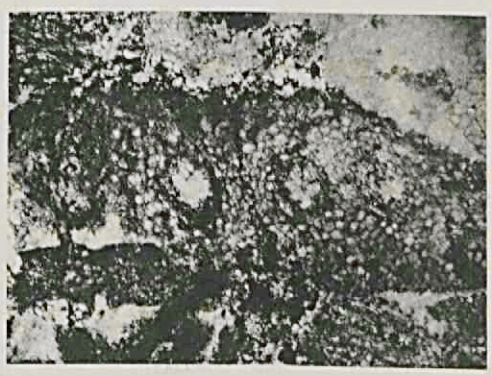

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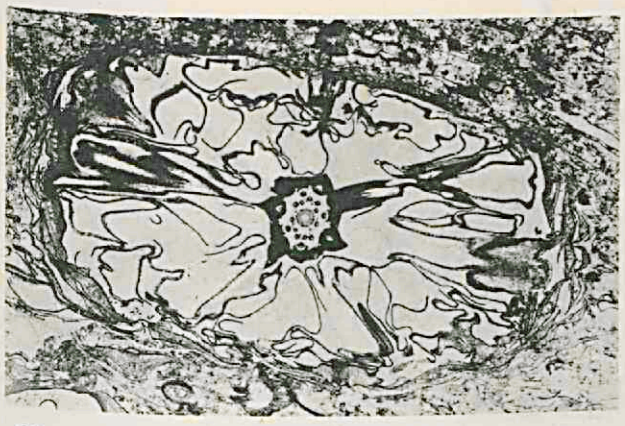
56-60 : *Lepidodendron aculeatum* — 61 : *Amyelon radicans* — 62-65 : *Cordaites Felicis*



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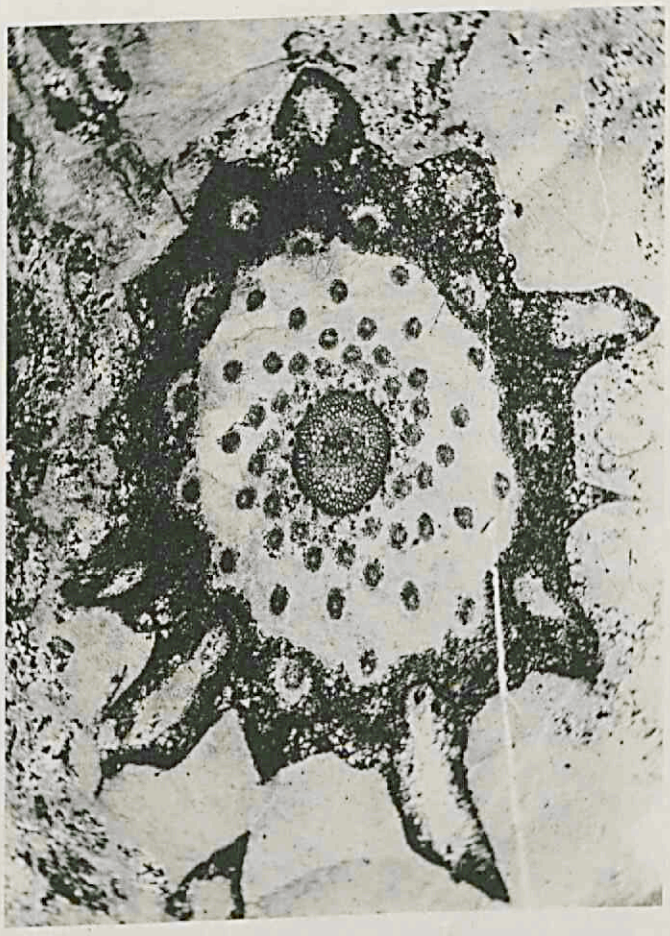

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66-70 : *Lepidostrobus oldhamius* — 71 : *Lepidostrobus foliaceus* — 72 : *Stigmaria arachnoidea*

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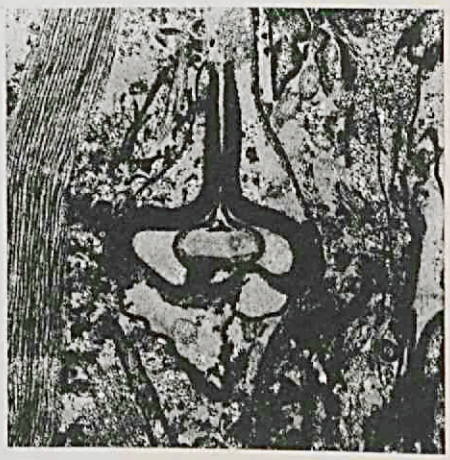

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73-75 : *Lepidostrobus Binneyanus* — 76-80 : *Lepidocarpon Lomaxi*

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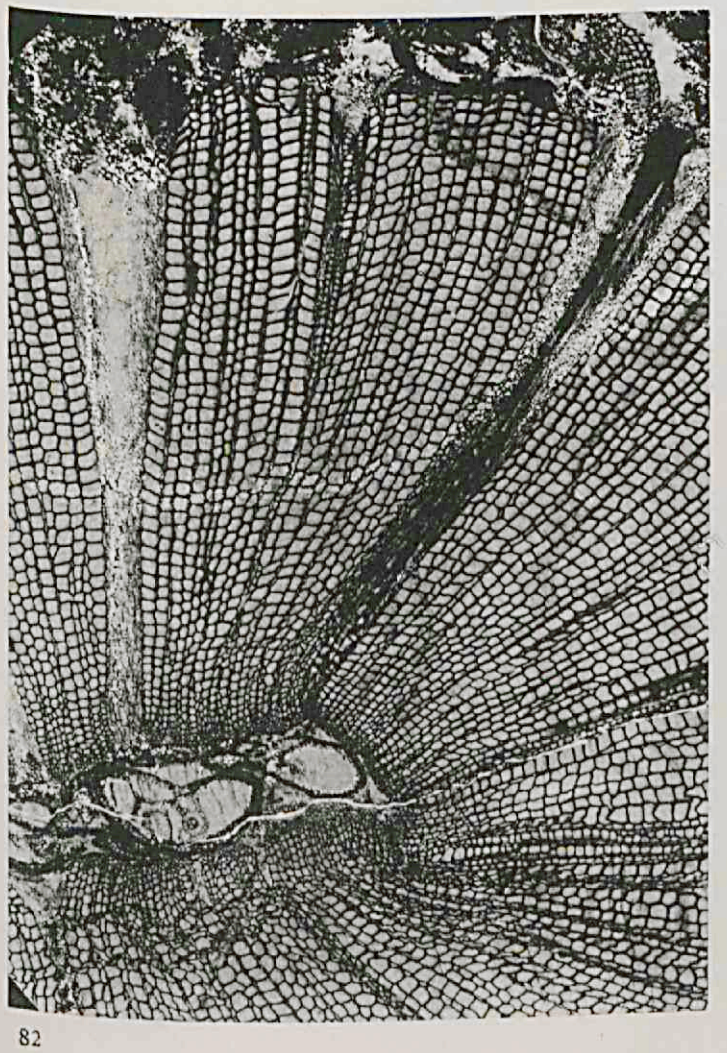

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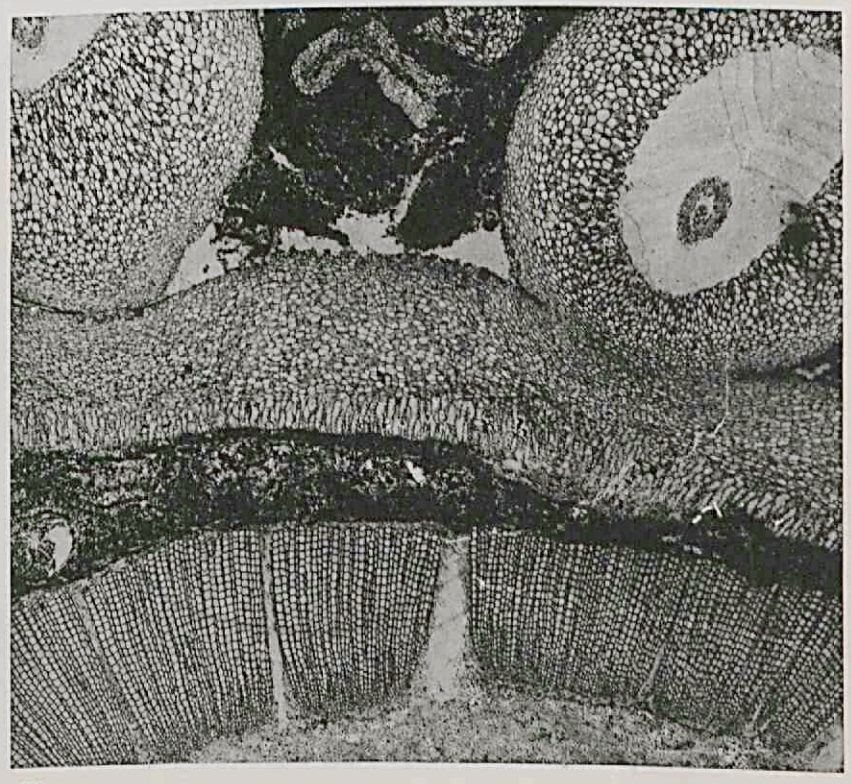

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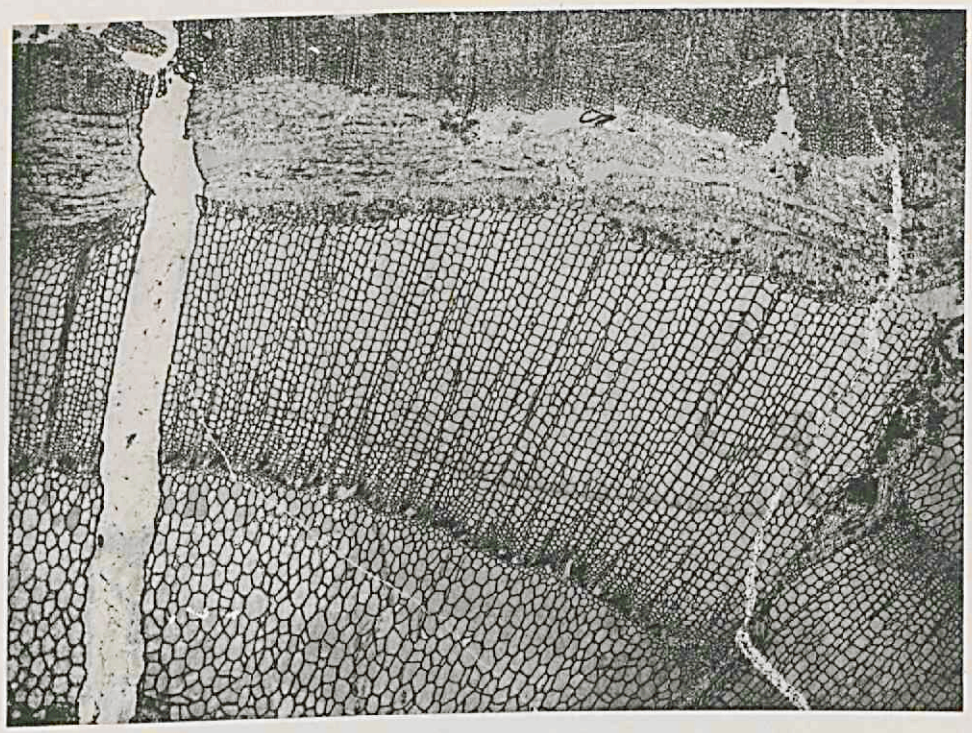
81-84 : *Stigmaria ficoides*

85



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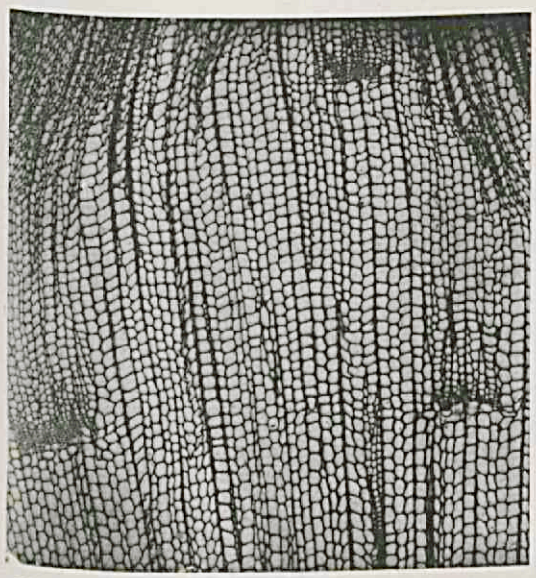

87

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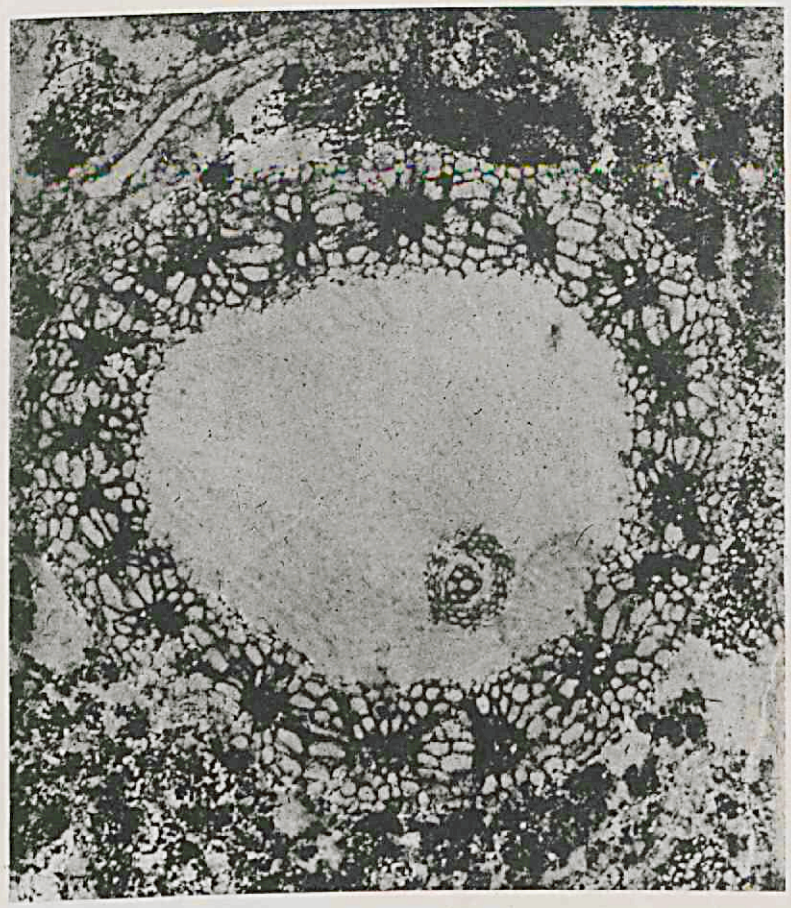
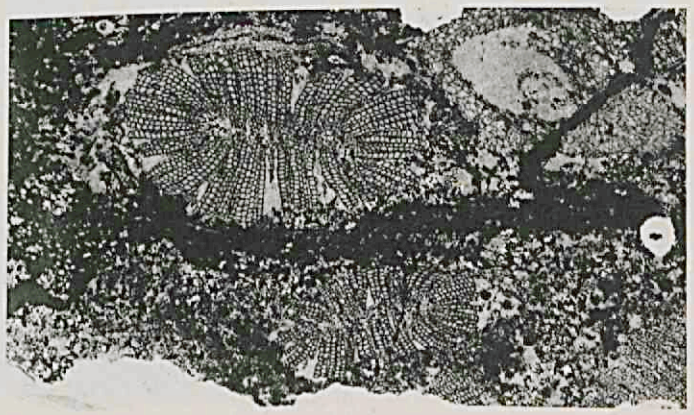
85-86 : *Diploxylon* 144 — 87-88 : *Diploxylon* 89
89 : *Lepidodendron obovatum* — 90 : *Lepidophloios macrolepidotus*

91



92

91 bis



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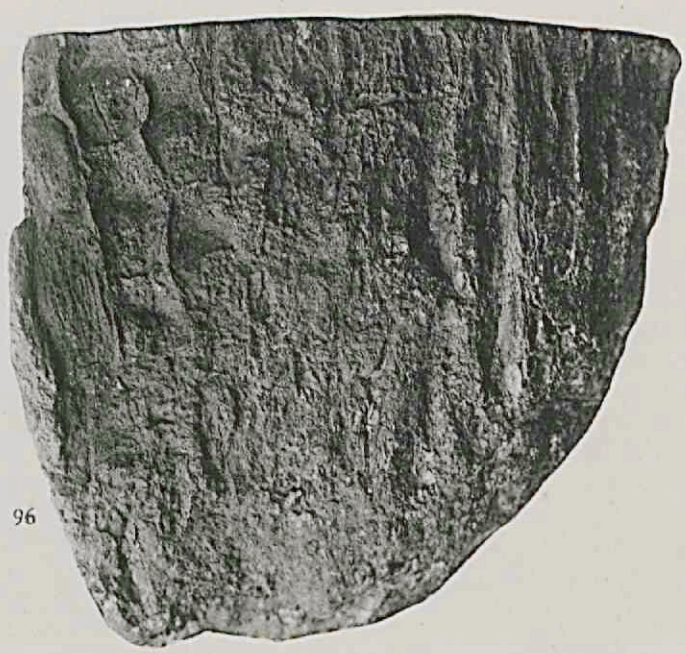
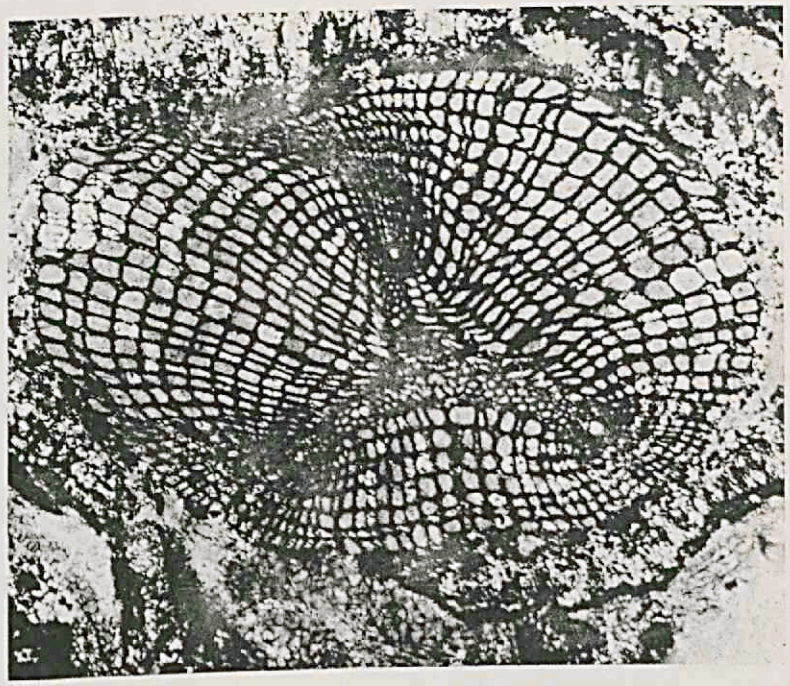


96

95

91-91 bis : *Lepidophloios macrolepidotus* — 92 : *Stigmaria arachnoidea* — 93 : *Stigmaria* cf.? *bacupensis*
94 : *Sigillariopsis laevis* — 95 : *Mazocarpon* cf. *shorense* — 96 : *Sigillaria mamillaris*

97



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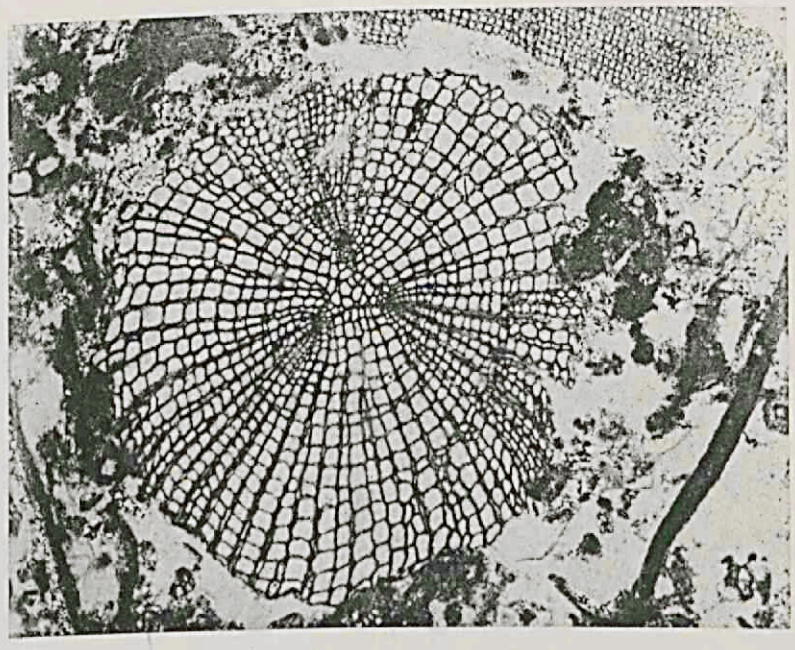

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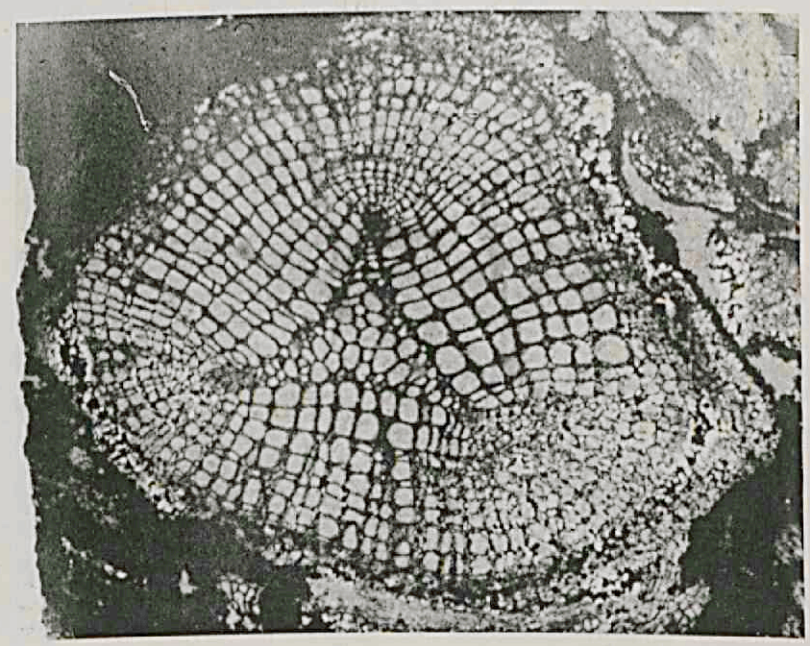
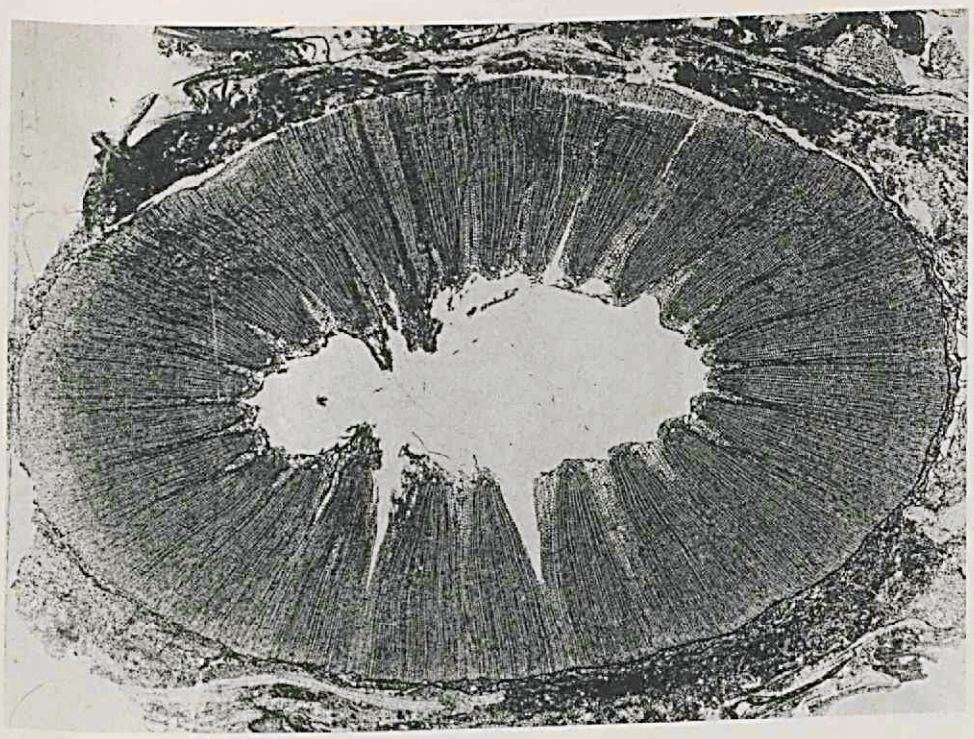


104

97 : *Sphenophyllostachys Dawsoni* — 98 : *Sphenophyllum perforatum*
99 : *Sphenophyllum minor* — 100-104 : *Sphenophyllum plurifoliatum*



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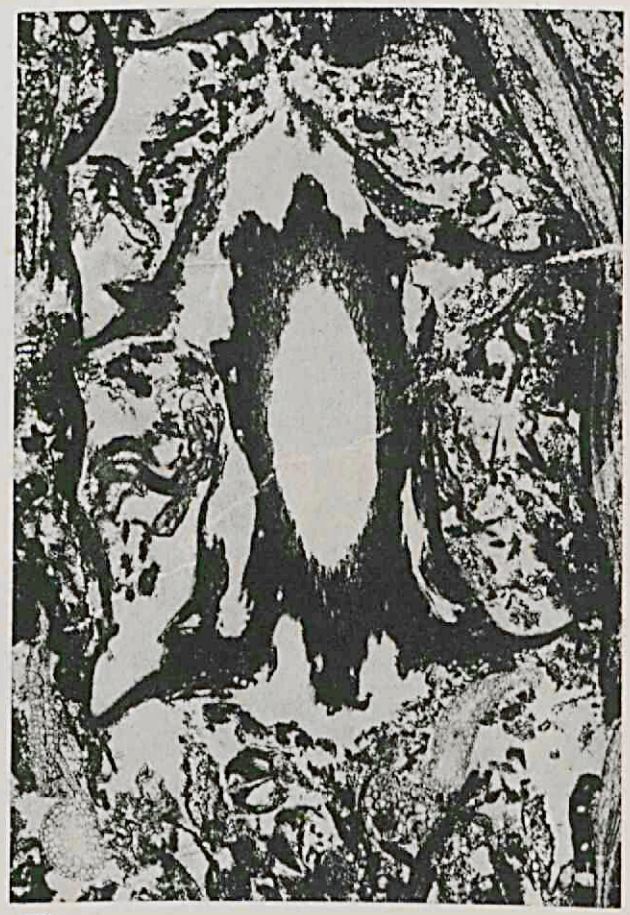

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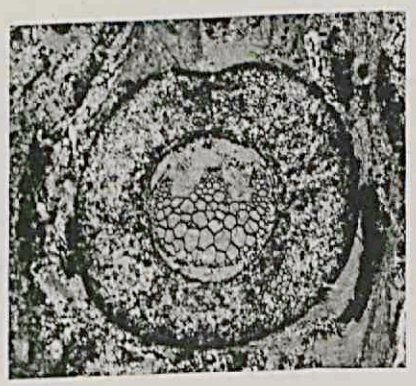
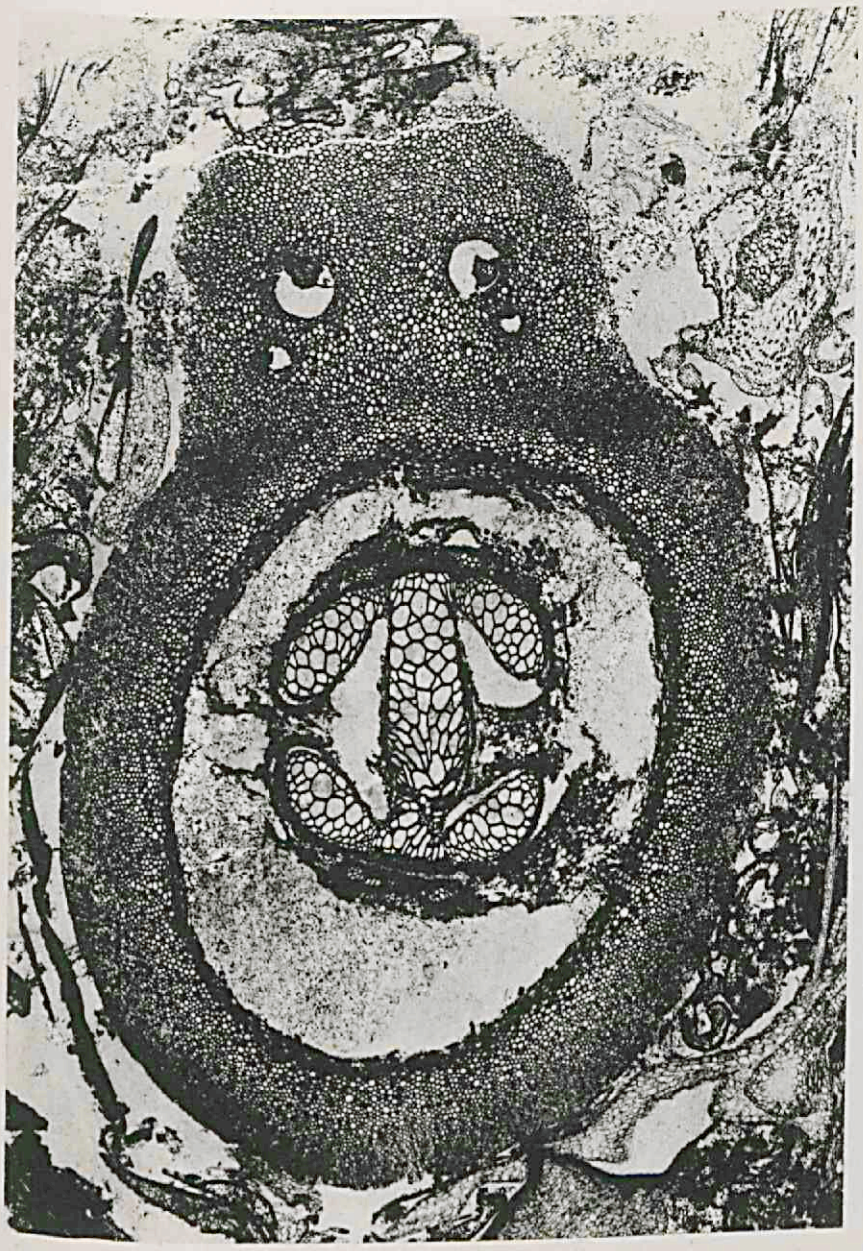


111

112

105 : *Calamites communis* — 106 : *Calamostachys oldhamia* — 107 : *Calamostachys Binneyana*
108-109 : *Palaeostachya vera* — 110-112 : *Botryopteris tridentata*



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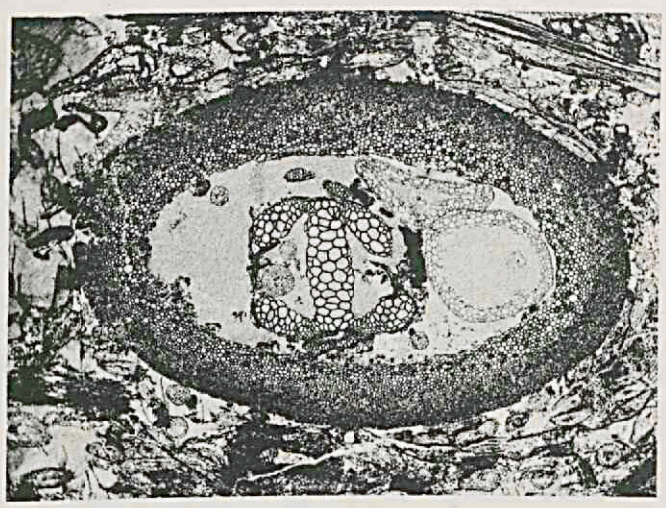

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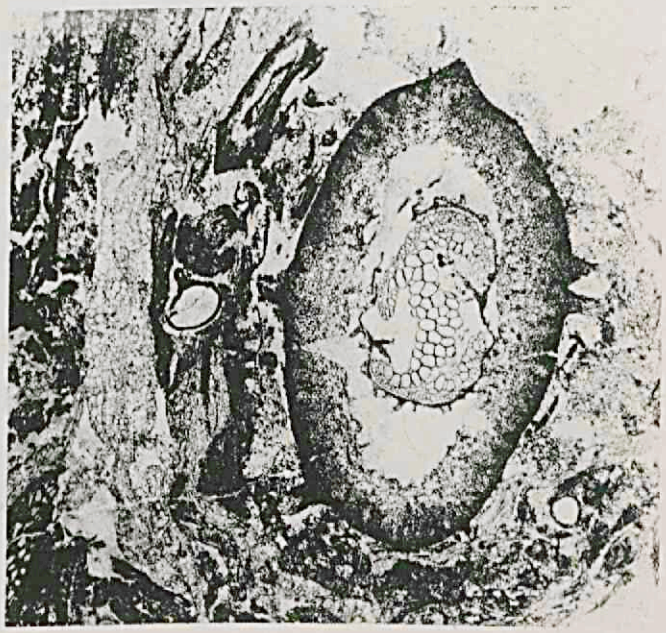

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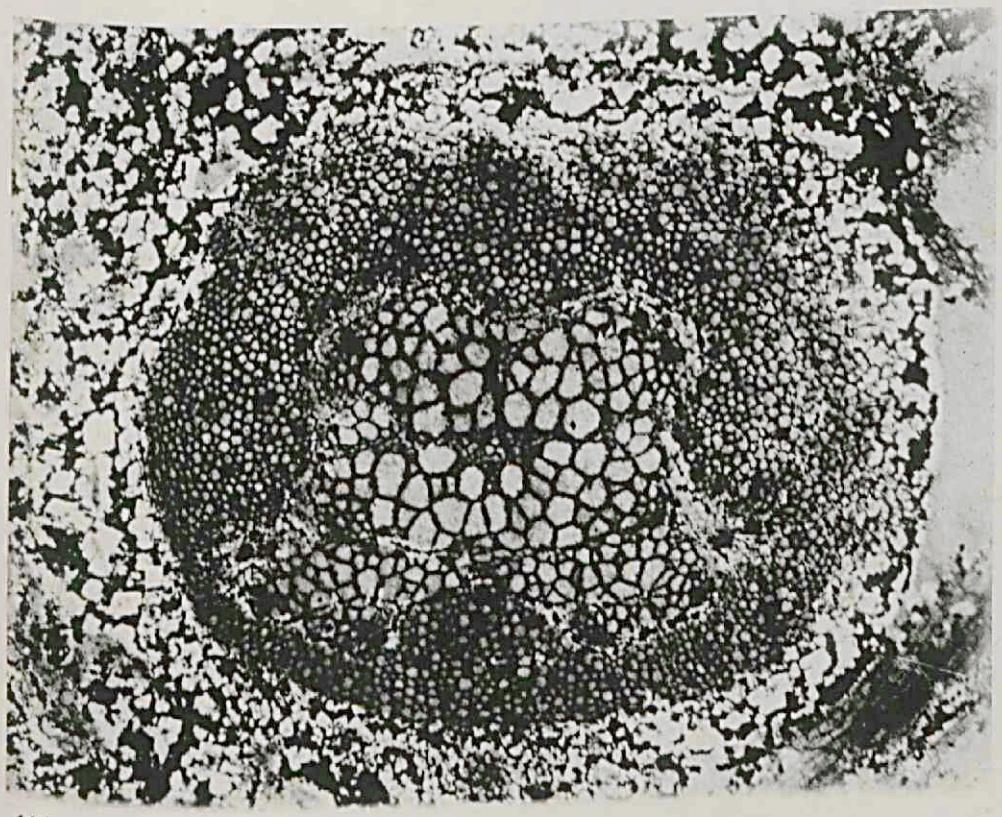

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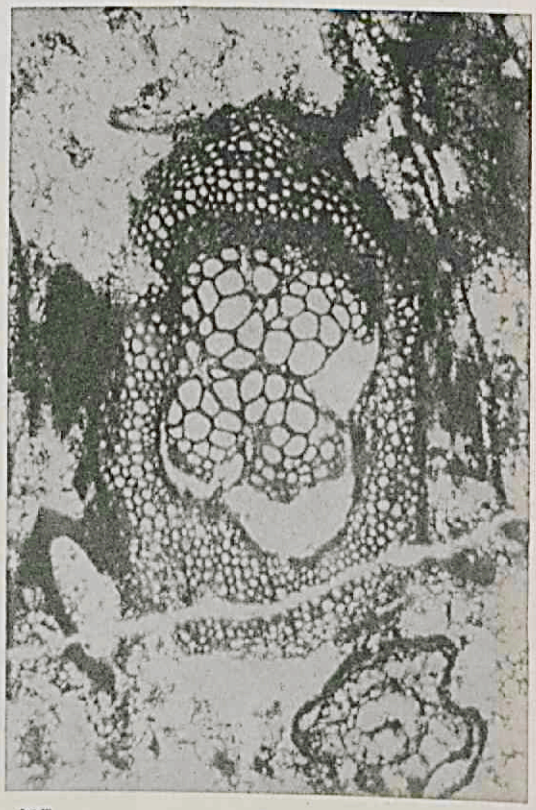
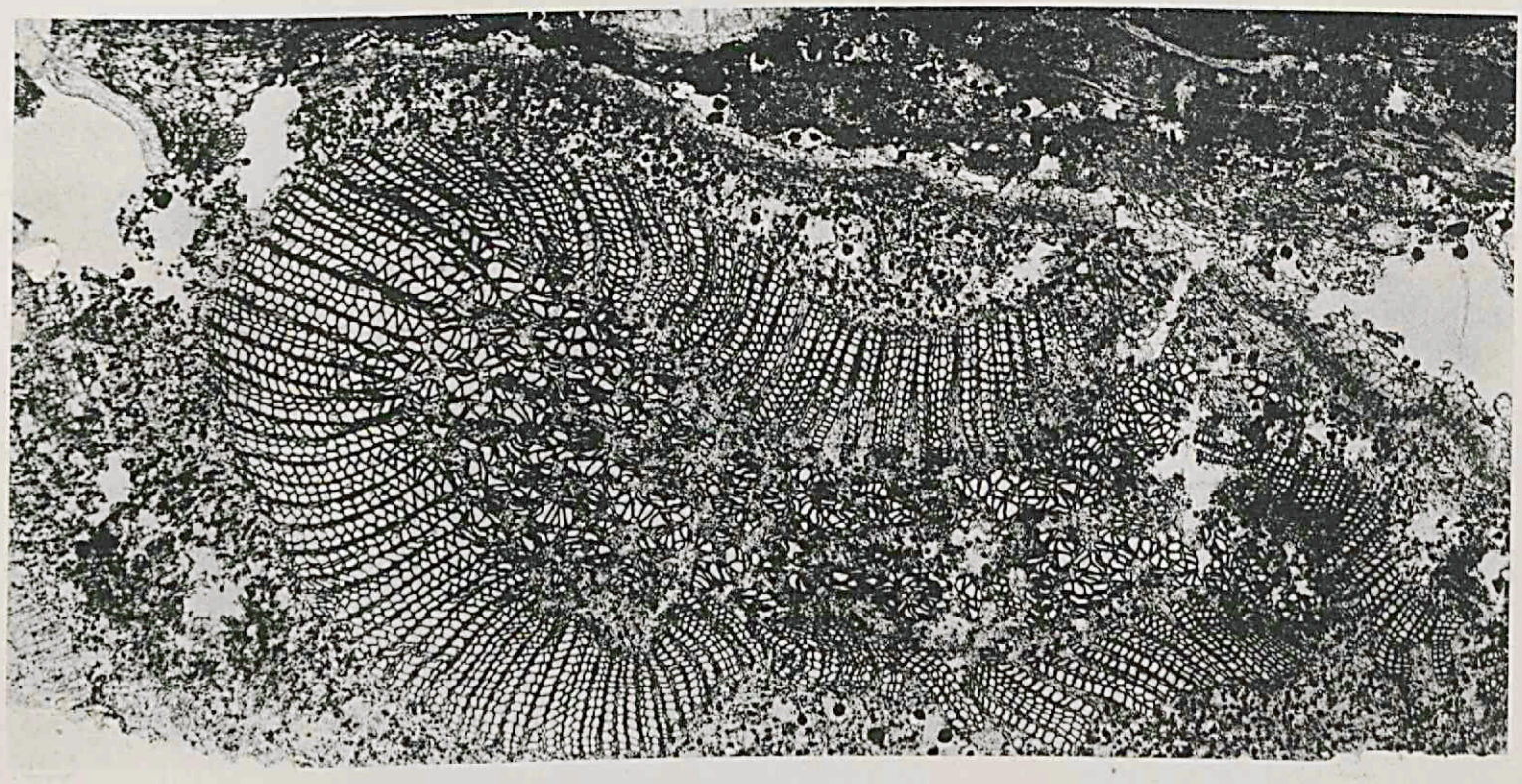


117

113-114 : *Etapteris Scotti* — 115 : *Ankyropteris westphaliensis* — 116-117 : *Stauropteris oldhamia*

118



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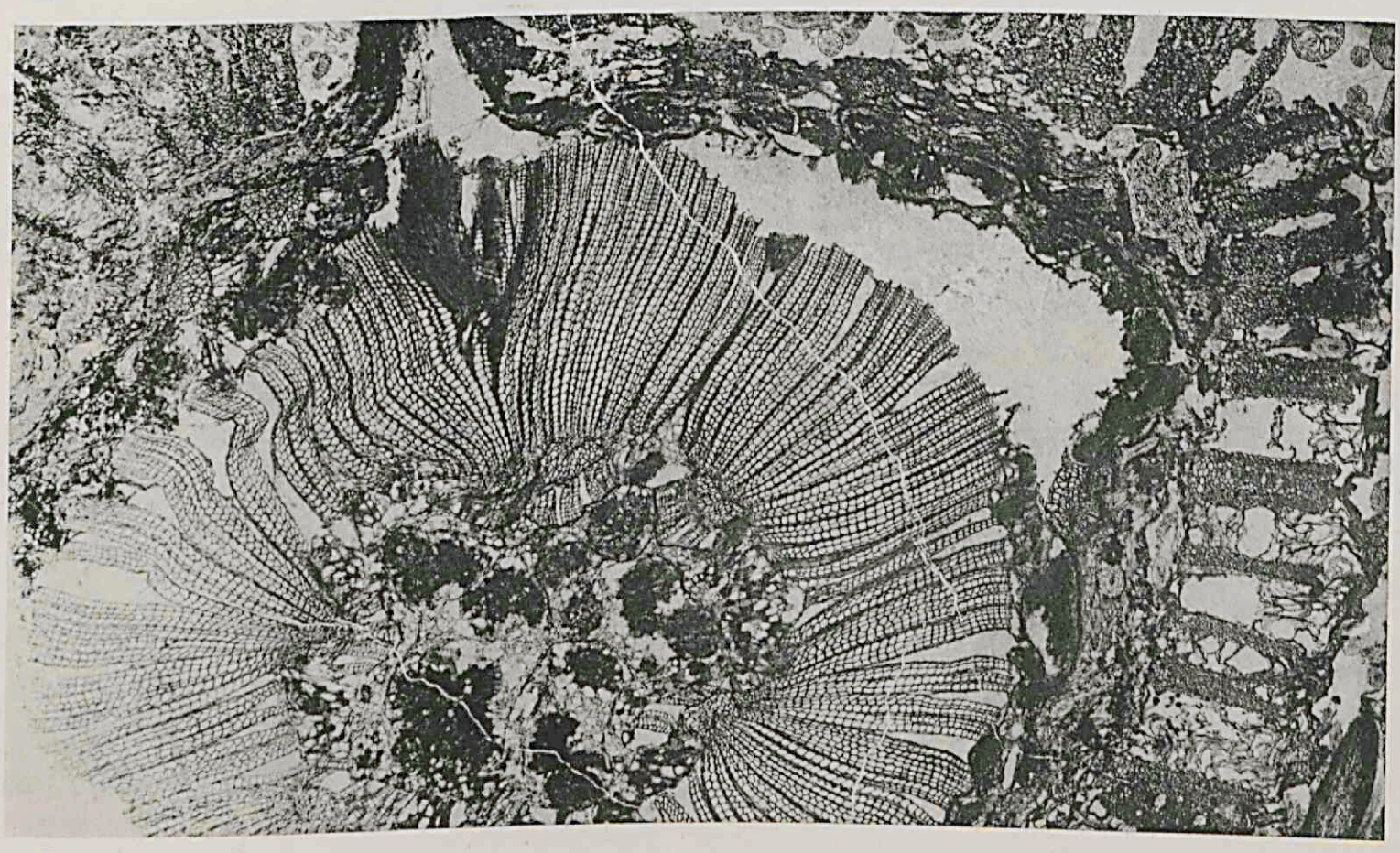
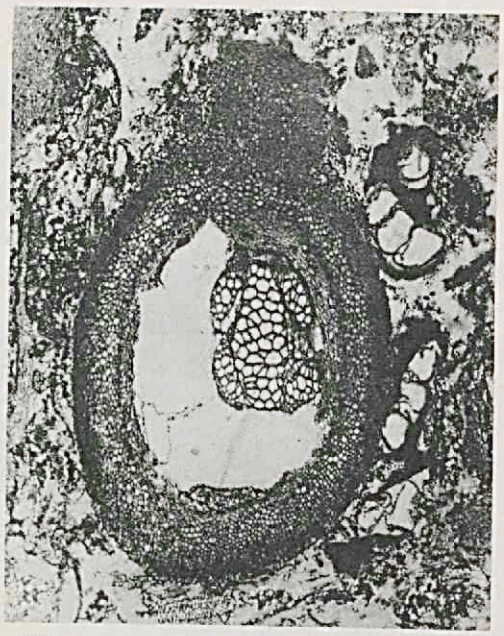


120

118-119 : *Medullosa anglica* — 120 : *Lyginopteris oldhamia*

121



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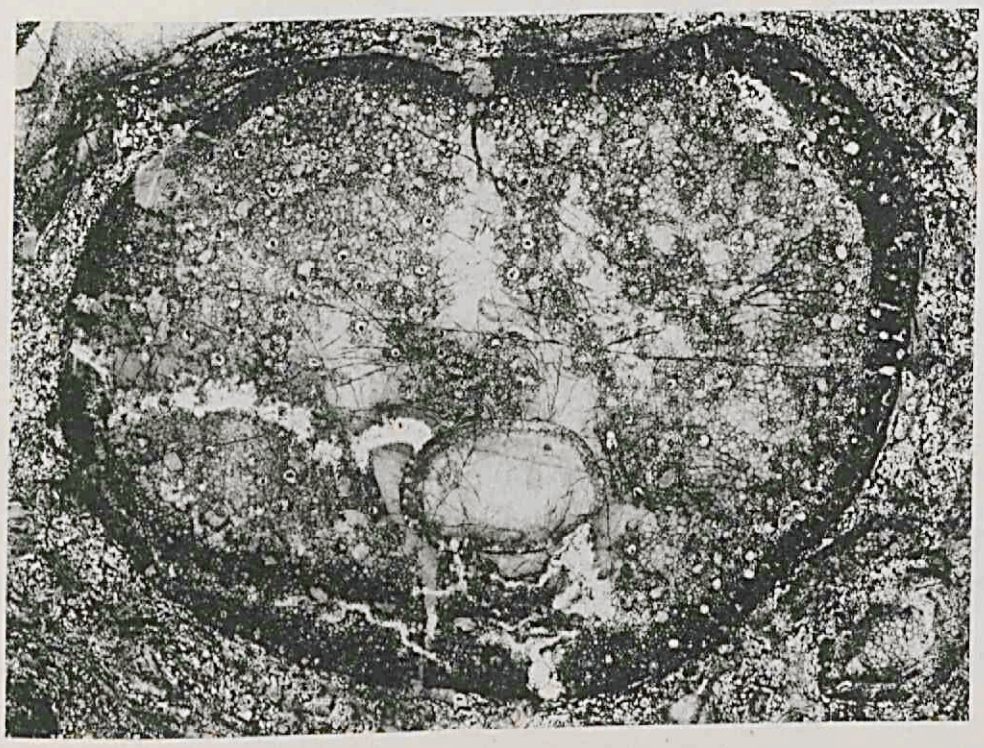

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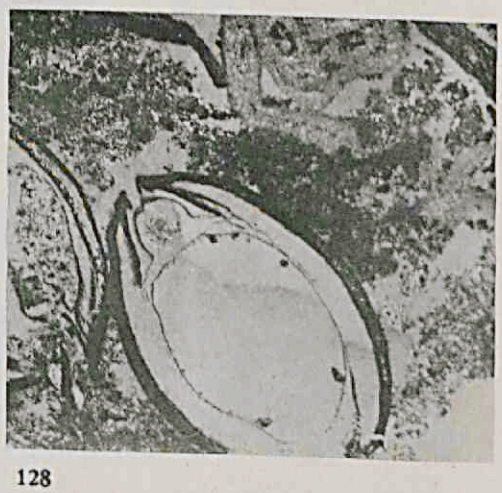
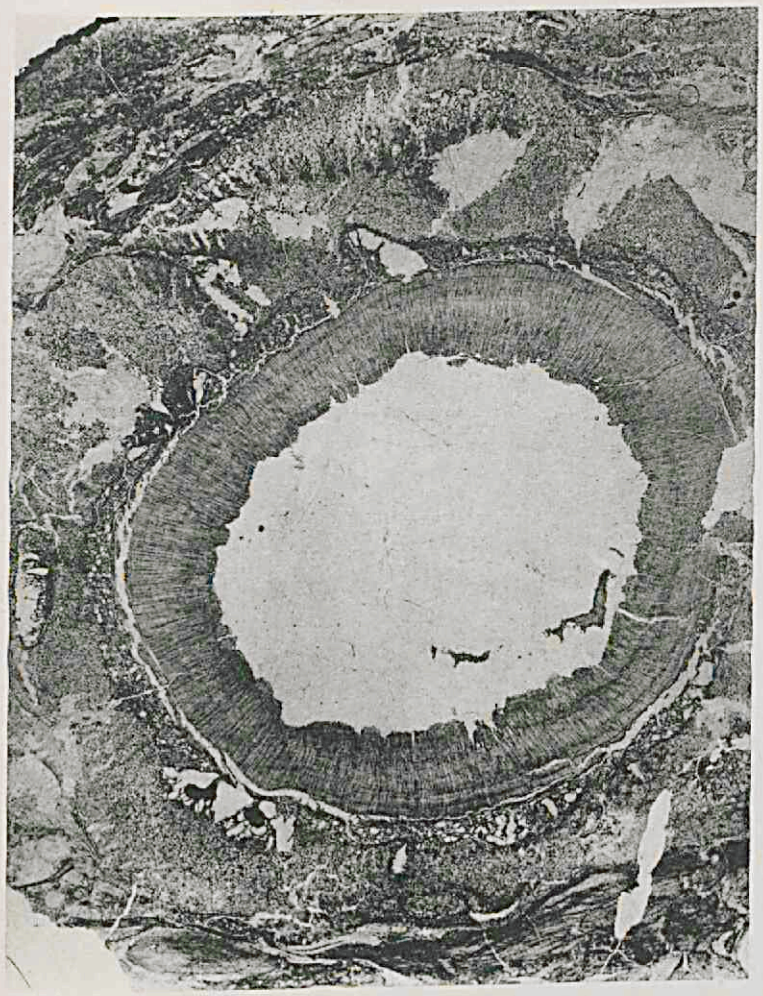


128

121 : *Medullosa anglica* — 122 : *Myeloxylon* — 123 : *Etapteris* cf. *Scotti* and cf. *Telangium Scotti*
124-125 : cf. *Telangium Scotti* — 126 : *Physostoma elegans* — 127-128 : *Lagenostoma ovoides*



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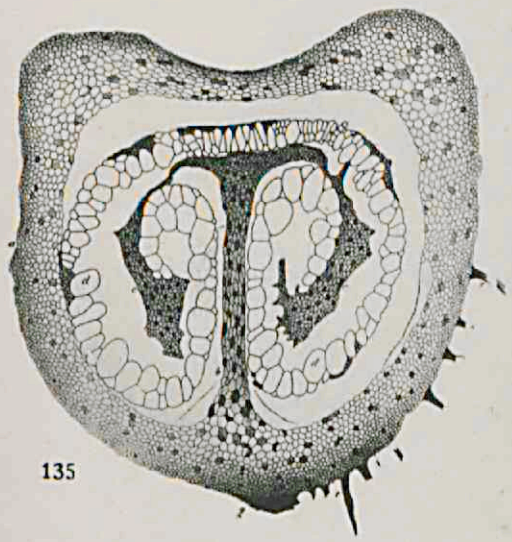

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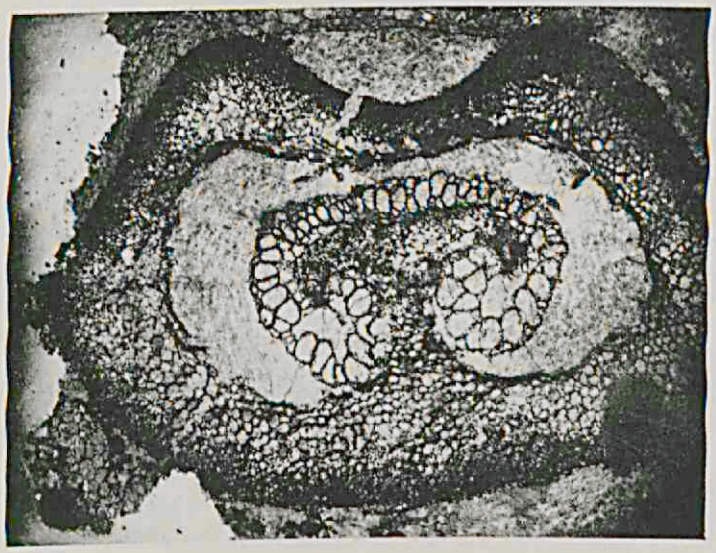

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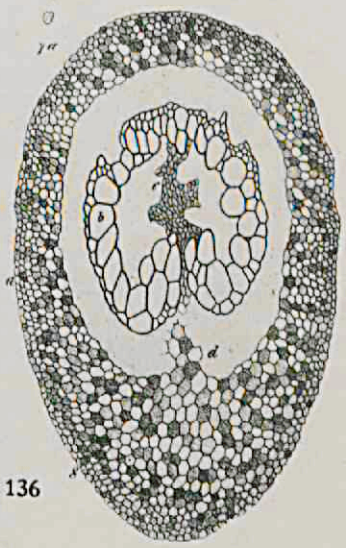

136

Imp. Tortellier et Cie, Arcueil (Seine)

129-132 : *Mesoxylon multirame* — 133-134 : *Anachoropteris Williamsoni*
135 : *Anachoropteris pulchra* — 136 : *Anachoropteris rotundata*